APPENDIX O

Agency & Public Engagement

Submitted Studies and Materials

- Woodmont Community (Steve Edmiston)
  - 1997 SeaTac International Airport Impact Mitigation Study
  - 2018 World Health Organization Noise Guidelines
  - Community Health and Airport Operations Related Noise and Air Pollution: Report to the Legislature in Response to Washington State HOUSE BILL 1109
  - 2020 SeaTac Legislative Report
- Bethel Public Schools Resolution 15 (22-23): A Resolution of the Board of Directors, Bethel School District #403, to Certify that the Board of Directors Opposes the Construction of an Airport in the Bethel School District Area (E.S.)
- Resolution No. R2023-12s: A Resolution of the Pierce County Council Objecting to the Siting of a New Airport at Any Greenfield Site in Pierce County; Requesting the Commercial Aviation Coordinating Commission (CACC) to Exclude Greenfield Sites in Pierce County from Its Final Preferred Location Recommendation for an Airport; and Requesting the Washington State Legislature Take Specific Actions (E.S.)
- Defenders of Highline Forest Community Forest Consensus (Defenders of Highline Forest)
- Public Signers Defenders of Highline Forest Community Forest Consensus (Defenders of Highline Forest)

SEA-TAC INTERNATIONAL AIRPORT IMPACT MITIGATION STUDY

INITIAL ASSESSMENT AND RECOMMENDATIONS
FEBRUARY 1997

PREPARED UNDER A GRANT FROM
THE STATE OF WASHINGTON FOR THE:

CITY OF BURIEN, WASHINGTON
CITY OF DES MOINES, WASHINGTON
CITY OF FEDERAL WAY, WASHINGTON
CITY OF NORMANDY PARK, WASHINGTON
CITY OF TUKWILA, WASHINGTON
HIGHLINE SCHOOL DISTRICT
HIGHLINE COMMUNITY HOSPITAL

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John Kennelly, Deputy Mayor

Kitty Milne, Councilmember

Sally Nelson, Councilmember

Don Newby, Councilmember

Kevin James, Councilmember

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The City of Burien wishes to thank all elected officials; local, state, federal and special purpose districts; and citizens that provided assistance during the course of this assessment.

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Executive Summary

EXECUTIVE SUMMARY

There is no doubt that the expansion of Sea-Tac International Airport will have a positive economic benefit for the region and the State. However, the costs associated with these improvements are disproportionately borne by those communities immediately surrounding the Airport. Communities such as Burien and Des Moines are projected to be impacted by noise, traffic congestion, and socio-economic hardship merely because of their location near the Airport. Of the estimated $2.95 billion in potential mitigation costs, $2.3 billion (almost 80%) is projected to be required for Burien and Des Moines alone. Other environmental, transportation, and socio-economic costs have not yet been calculated.

This study does not assign mitigation costs to any particular agency. While the Port of Seattle and the Federal Aviation Administration will be financially responsible for a portion of the mitigation costs, funding from other sources is also expected. For example, increased transportation funding is available through the Washington State Department of Transportation and the Federal Highway Administration. Some environmental mitigation costs may be eligible for State and Federal EPA funding. Costs associated with acquisition and redevelopment may be shared between private and public-sector interests.

This study also does not dispute the projections included in the EIS, such as noise contours and future flight-tracks. It recommends that these projections be assumed as accurate and that any required mitigation program(s) be based on the Airport meeting - not exceeding - these projections. For example, a permanent noise monitoring program should be established to verify that the projected noise contours are not exceeded. Should these or other parameters be exceeded, the EIS should be re-conducted and additional mitigation programs be developed, This approach positively works with the Port of Seattle to assure both the Airport and Airport-area communities that the EIS will be a valid document.

The study also recommends the need for an overall planning approach to development in Southern King County. The study recommends the development of a "South King County Comprehensive Plan" to weave together a plan that addresses the needs of all interests in the area - communities, residents, businesses, schools, hospitals, the environment, and the Airport.

Project Parameters

This report was produced under a grant from the State of Washington to analyze the proposed Third Runway project at Sea-Tac International Airport. The City of Burien, acting in the capacity of the grant manager, supervised the consultant team. The study examined the potential impacts of the Airport project on neighborhoods in the surrounding communities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila. Potential impacts on facilities owned and operated by the Highline School District and Highline Hospital were similarly examined.

Mitigation of potential impacts was based on the preservation and protection of neighborhood integrity. The consultants conducted an independent investigation into the potential impacts of the proposed project and how these potential impacts could be most appropriately mitigated.

Several other parameters guided this study:

- The basic premise of this study was that the Third Runway project would be constructed. This premise was clearly stipulated in the State grant which states that the funding for the study could not be *"expended directly or indirectly for litigation, public relations, or for any consulting services for the purposes of opposing the construction of the proposed Third Runway"*.

- Neighborhood boundaries were established by each community through their comprehensive planning process.

- The economic importance of Sea-Tac International Airport was never questioned. The Airport is an important economic factor to the Seattle metropolitan area, the Puget Sound Region, and the State of Washington.

- Given the study's budget and schedule, the consultants agreed to utilize as much existing information as possible. No new data was developed as part of this study. Information was primarily taken from the Master Plan Update Environmental Impact Statement, with additional information coming from other agencies including King County, the Puget Sound Regional Council, and various State and Federal agencies.

- The study investigated potential impacts associated with the proposed Third Runway and its associated facility improvements. Mitigation for existing impacts associated with the existing runways and airport operations were not included.

During the course of this study (April 1996 through March 1997), the consultants conducted over 100 meetings, interviews, presentations, workshops, and question-and-answer sessions with: local elected and appointed officials and staff members; the Port of Seattle staff and its consultants; County and State elected officials; representatives from various City, County, State, regional and Federal agencies; and the general public.

Potential Environmental Impacts

The study examined 8 general environmental areas and 26 specific potential impacts.

Potential Environmental Impacts Studied

Area	Specific Impact
Noise and vibration	LDN SEL Overflights (TA) Vibration
Air quality	Air emissions (aircraft) CO emissions (vehicles) HC emissions (vehicles) Air toxics Fugitive emissions Point source pollution
Surface water quality/hydrology	Runoff volume Erosion and sediment Spills
Ground water quality/hydrology	Aquifer recharge Contamination
Wetlands	Wetlands
Floodplains	Encroachment Reduced flood storage capacity Increased flow rate and volume
Aesthetics and visual	Ground shadow Visibility (aircraft) Visibility (fill)
Other	Special status species habitat Cultural resources Coastal zones DOT Section 4(f) resources

Of these 26 parameters, the consultants estimated the costs of mitigating the potential noise and vibration impacts. These costs are estimated to be approximately $2.4 billion, which primarily occur in 5 neighborhoods in 2 communities.

Neighborhoods Identified for Potential Acquisition and Redevelopment

City	Neighborhoods
Burien	North East
Des Moines	West Central North Central East Central South Des Moines

Mitigation of these neighborhoods are estimated to be approximately $1.9 billion - 80% of the total environmental impacts. These 5 neighborhoods are the closest to the proposed project and will experience significant impacts, due primarily to noise and vibration of aircraft operations. The $1.9 billion figure represents the cost to relocate neighborhood residents and redevelop the area.

Acquisition and redevelopment is the most far-reaching mitigation measure for these areas, but it will also fundamentally change these neighborhoods. The study recommends that a "specific area plan" be developed for each of these 5 neighborhoods in order to determine if other mitigation measures are appropriate. Acquisition and redevelopment is recommended only if all other mitigation measures are unsuccessful.

For the other communities, it was estimated that Federal Way would require mitigation due to LDN contours and overflights ($148 million), and that Normandy Park and Tukwila would require mitigation due to LDN and SEL noise, and overflights ($56 million and $114 million, respectively). Mitigation in these 3 communities would involve primarily sound abatement insulation and the purchasing of avigation easements.

The study also recommended the replacement or relocation of 8 schools in 3 communities.

Schools Identified for Potential Replacement or Relocation

Area	Elementary Schools	Middle Schools	High Schools
Burien	Sunnydale Cedarhurst	(none)	(none)
Des Moines	Midway	Pacific	Mount Rainier
Unincorporated King County	Beverly Park White Center	(none)	Satellite Alternate

Twenty-six other schools in the Highline School District were identified for sound abatement insulation and avigation easements. Costs involved with both the replacement and insulation/easement programs were not estimated by this study. Additional structural studies will be required in order to determine the costs involved with school mitigation.

Given the amount of information available and the project's budget and time constraints, it was not possible to calculate the mitigation costs for potential impacts associated with the remaining environmental measures (wetlands, floodplains, aquifer, air quality, etc.). Additional studies should be commissioned to determine the potential impacts associated with the Airport's proposed project.

Potential Transportation Impacts

The study examined 4 general environmental areas and 21 specific potential impacts.

Potential Transportation Impacts Studied

Area	Specific Impact
Congestion	Level of service
	Accidents
	School bus operations
	Transit bus operations
	Police and emergency vehicle operations
	Parking and pedestrian access
	Traffic noise (LEQ)
Physical damage	Local streets
	State roads
	State bridges
	Increased maintenance and reconstruction
Construction impacts	Truck haul routes
	Barge/rail/conveyor system
	Traffic diversion
	Traffic control
	Construction staging and phasing
	Work-force traffic
	Concurrent construction projects
Post-construction impacts	Additional traffic
	Increased operation and maintenance costs
	Master plan update

Of these 21 parameters, potential mitigation costs are estimated to be approximately $479 million. Tukwila accounts for $192 million (40%), due primarily to the number of State-jurisdiction roads and bridges in the City. Burien and Des Moines were projected to have the second and third highest mitigation costs ($117 million and $73 million respectively), due to their close proximity to the Airport's west and south sides. Normandy Park and Federal Way had the lowest potential mitigation costs due to their location relative to the Airport.

An advantage with many transportation mitigation measures is that one measure may concurrently address multiple potential impacts. For instance, improvements to a roadway to increase its capacity simultaneously addresses congestion, accident, and pollution impacts.

While the EIS did a good job of analyzing transportation impacts, it did not study a large enough area. The Airport serves the entire Central Puget Sound Region, yet the transportation impacts studied in the EIS stopped at the Airport's "driveways" - the roadways leading directly into the Airport property. Additional studies are needed to determine the true scope of the transportation-related impacts.

Given the amount of information available and the project's budget and time constraints, it was not possible to distinguish between future traffic directly associated with the expanded Airport and future traffic as a function of the region's natural growth. Additional studies - such as an origin-destination survey, a select link analysis, and a cost allocation model - are needed in order to make this distinction and to appropriately assign costs to appropriate funding sources.

Potential Socio-Economic Impacts

There is an inequity regarding the benefit of the Airport to its immediate neighbors. While the study acknowledges the benefit of the Airport to the region and the State, these benefits are not experienced locally in the 5 impacted communities. Approximately 5% of the persons utilizing the Airport live in the area most impacted. The remaining 95% of Airport passengers and employees come from elsewhere in the region.

Socio-economic impacts tend to blur across neighborhood lines and impact entire communities. In general, communities closer to the Airport are expected to experience a relative "depression" of residential property values (property values do not rise as fast relative to other similar properties in the region). This will have a cascading affect on the population mix in these areas. Single-family homes that cannot be sold will become rental properties. Studies have reported that non-owner-occupied residential areas have a lower average household income and utilize more social services than other areas. While the property value and tax revenues are depressed in these areas, the cost of providing social services increases.

Overall, the 5 communities were projected to experience a loss of $39.9 million during the period 2000 through 2020 as a result of the proposed project. The loss of these revenues is compounded with the problem of increasing demand for community and social services.

The discrepancy between these two trends contributes to the "blighting" of the area. This "blighting" impact has already been observed. Homes take longer to sell in the neighborhoods adjacent to the Airport, and the local real estate market already acknowledges the impact of aviation activity on neighborhoods.

The study recommends that the Port of Seattle make partial off-setting payments to the 5 impacted communities in order to mitigate the loss of local government revenues over the project period (2000 through 2020). An analysis of similar revenue shortfalls in the Highline School District are also needed.

Principal Environmental Recommendations

The following recommendations are included in Section 7 of the study. Please refer to Section 7 for a complete description of the study's environmental recommendations.

- **Oversight Commission** - Establish a working group/oversight commission to interact with the Port of Seattle during Master Plan Update implementation.

- **Acquisition and Redevelopment Program** - A study should be conducted to consider each neighborhood and school to determine if there are other less disruptive alternatives to acquisition and redevelopment. This study should be completed prior to construction of the Third Runway.

- **Sound Insulation and Avigation Easement Program** - The neighborhoods and schools identified in Section 7 (Tables 7.03, 7.04, and 7.05) should be further studied to determine the full extent of the proposed insulation and easement program. This study should be completed prior to construction of the Third Runway.

- **Vibration** - Prior to the start of construction of activities associated with Master Plan Update implementation, additional information should be provided regarding the potential impacts of vibration from construction activities. Also expand the vibration analysis to include qualitative and quantitative information on whole body vibration, annoyance/interference to humans caused by building vibration, and building structural damage for residences, schools and hospitals in the Airport area.

- **Additional Noise and Vibration Recommendations** -
  - Run the latest version of the Integrated Noise Model.
  - Show the SEL contours for the preferred alternative.
  - Show the 55 LDN contour.
  - Expand the permanent noise monitoring program.
  - Use the Third Runway only for arrival flights during inclement weather.
  - Restrict runway use between 9:00 PM and 7:00 AM.
  - Provide additional information regarding the threshold above (TA) noise metric.
  - Use permanent/portable "hush houses" in conjunction with engine maintenance run-ups.
  - Keep departure tracks over water as much as possible.
  - Re-evaluate use of noise barriers.

- **Minimize Overflights** - Minimize low-altitude overflights of residential areas as discussed in the Flight Plan Project EIS.

- **New Technologies** - Consider implementation of new technologies such as Microwave Landing System and Global Positioning Satellite System to reduce noise impacts around the Airport.

- **Aircraft Operations** - Clarify both hourly operational capacity of Airport and the calculation of existing average daily operations.

- **Reduced Noise Levels** - Provide information on the ability to maintain the Airport's reduced noise level goals.

- **Dust and Particulate Matter** - Include a Dust Control Plan in the contractor's permit prior to construction of the Third Runway. Work with appropriate regulatory agencies to obtain PM_{10} data which is more representative of the Puget Sound Region. This should entail the establishment of additional air quality monitoring stations, in particular in the vicinity of the Airport.

- **Air Quality** - Add additional air quality monitors closer to the Airport. Construction vehicle air quality analysis should be re-evaluated and the dispersion analysis should be re-done to better predict potential air quality impacts prior to the start of construction. As part of construction activities, PM_{10} and CO should be monitored in the vicinity of the fill sources, along the haul routes and in the Airport construction area. Provide information on Master Plan Update implementation and conformity with the Clean Air Act. Provide information on the State of Washington's Certification of Compliance with Air Quality Standards and a copy of Governor's Air Quality Certificate. After one year of baseline data has been collected at the new air quality monitoring sites, the area dispersion analysis should be re-evaluated for both the existing and future conditions. Conduct additional studies regarding long-term exposure to air toxics associated with Airport operations.

- **Mobile Sources** - Re-evaluate the existing and future roadway intersection analysis to confirm the accuracy of the evaluation in the EIS and to correct for inconsistencies discussed by EPA. All vehicles associated with Airport operations should comply with required vehicle emissions inspections and maintenance programs.

- **Queuing and Taxiing** - Conduct a study to determine the possibility of reducing aircraft emissions by improving Airport operations associated with queuing and taxiing.

- **Master Plan Update** - Re-evaluate the air dispersion and roadway traffic analysis to accurately monitor potential impacts.

- **Geotechnical Engineer** - Hire a geotechnical engineer for the duration of construction of the Third Runway to ensure that fill is placed appropriately including compaction and to help detect and remove seismically unstable soils, such as in fill sources.

- **Toxic-Free Fill** - Provide evidence including appropriate certifications that all fill material is free of harmful levels of toxic and hazardous materials as defined by current Federal and State regulations. Prior to the start of construction, conduct baseline studies of any area surface waters and the ground water. This information should be used to describe the existing conditions and to help monitor potential changes after the earthwork activities are complete.

- **Plans for Review** - At least two months prior to construction, provide for review and approval the following:
  - Construction Stormwater Pollution Prevention Plan and Erosion/Sediment Control Plan.
  - Spill Prevention, Control and Countermeasure (SPCC) Plan.
  - Construction Management Plan.
  - Construction Waste Management Plan.
  - Geotechnical report.
  - Reclamation plan for proposed fill sources.
  - Earthwork specifications and drawings, in particular for the Third Runway.
  - A copy of the State of Washington Governor's Water Quality Certificate which indicates that there is reasonable assurance that the project will be designed, constructed and operated in compliance with applicable water quality standards.

- **Groundwater** - Prior to the start of construction, permanent, long term surface and groundwater monitoring stations should be established in the Airport area. The locations and number of these stations should be approved by a working group/oversight commission.

- **Highline Aquifer** - Ground water movement in the Airport area should be better defined prior to the start of construction. Additional studies should be reviewed for potential ground water contamination impacts on the Highline Aquifer and other area aquifers.

- **Miller/Des Moines Creek Monitoring Studies** - Provide results of creek monitoring studies prior to the start of construction.

- **Stormwater Detention** - If the preferred alternative is implemented, the hydrologic analysis and stormwater management facilities should be re-evaluated to support final design prior to the start of construction.

- **Wet Vaults/Biofiltration Swales** - Provide detailed information regarding the construction and operation of the wet vaults and biofiltration swales

- **Construction Fence** - Place a construction fence at the outside limits of the construction area.

- **Miller Creek Relocation** - Prior to the start of relocating any part of Miller Creek, provide information on the potential impact on the relocation of litigation concerning King County agreeing not to channelize the Creek except in limited amounts in connection with retention facilities.

- **Expansion Storm Drain System Report** - Provide a copy of the hydraulic analysis with the computer program for review and comment.

- **Surface/Groundwater Monitoring** - Continue the surface and groundwater monitoring prior to the start of construction.

- **Borrow Site Hydrology** - Continue the borrow site hydrology until adequate information is obtained for comparison with the EIS existing or baseline conditions.

- **Operations Erosion and Sediment Control Plan** - At least two months prior to the completion of construction on the Third Runway, provide an operations erosion and sediment control plan, and a stormwater pollution prevention plan.

- **Fuel Handling System** - Upgrade and modernize the Airport's fuel handling system.

- **Floodplains** - At least two months before the start of construction, provide: information on the relationship between the 100 and 500-year floodplains, recent storms in the Puget Sound region and the Master Plan Update implementation EIS analysis; a copy of the final monitoring plan for evaluating the effectiveness of the Miller Creek and Des Moines Creek relocations; and final design information for the Miller Creek and Des Moines Creek relocations including specifications and drawings.

- **Color Photographs** - Provide color photographs taken from the EIS viewpoints and additional viewpoints which show the existing and future conditions. The additional viewpoints should be selected based on discussions with a working group/oversight commission.

- **Landscape Plans** - Landscape plans should consider: landscape requirements from the City of SeaTac; planting temporary vegetation or a cover crop as construction is completed; and should include a variety of native vegetation which requires low maintenance and has a mixture of seedlings and more mature plants in order to avoid a monoculture.

- **Coastal Zone Mitigation** - Potential point sources for pollutants should be identified and a pollution control management plan developed for the neighborhoods identified in Section 7 (Table 7.15).

- **DOT Section 4(F) Resource Mitigation** - Significant open spaces, parks, and recreational areas should be preserved and protected from potential impacts, or should be relocated and replaced if possible.

- **Sub-Regional Comprehensive Plan** - Conduct a comprehensive plan for all communities in the South King County region in order to integrate all future plans for land development, transportation, infrastructure, parks and open space, environmental protection, economic development, and other similar plans.

Principal Transportation Recommendations

The following recommendations are included in Section 8 of the study. Please refer to Section 8 for a complete description of the study's transportation recommendations.

- **Origin-Destination (O-D) Survey** - Conduct an O-D survey to determine the amount of regional traffic attributable to Sea-Tac International Airport. The percentage of traffic attributable to the Airport should be projected to the Year 2020 in 5-year increments and be used for projecting cost-sharing of various transportation projects that serve and benefit the Airport.

- **Recalculate Mitigation Costs** - Estimated mitigation costs calculated in Section 8 of this report should be recalculated taking into consideration the O-D information recommended above. Costs for mitigation projects should be assigned to the Port of Seattle only if those impacts are attributable to traffic as a result of the Third Runway. Other transportation projects would be implemented by the appropriate local, county, State, and/or Federal agencies.

- **Level of Service** - Areas identified in Section 8 (Table 8.03) should be mitigated prior to construction of the Third Runway.

- **School Buses** - Any additional mitigation for Highline School District school bus impacts should be assessed and completed prior to commencement of construction of the Third Runway.

- **Transit** - Any additional transit impact mitigation should be assessed and completed prior to commencement of construction of the Third Runway.

- **Public Safety** - Public safety response times in the five impacted communities should be continually monitored during the construction phase of the Third Runway. Reductions in response times should be addressed by additional equipment, personnel, or new station locations.

- **Local Jurisdiction Roadways** - Areas identified in Section 8 (Table 8.04) for local street mitigation should be continually monitored for serviceability index (SI) decreases. Roadways where the SI decrease should be reconstructed as soon as possible.

- **State Jurisdiction Roadways** - It is recommended that the areas identified in Section 8 (Table 8.05) for State street mitigation be continually monitored for SI decreases. Roadways where the SI decrease should be reconstructed as soon as possible.

- **State Jurisdiction Bridges** - Establish the baseline conditions of the bridges and pavement on the freeway routes most likely to be used from the borrow pit locations to the construction site and establish a system of monitoring prior to any truck movements.

- **Maintenance and Reconstruction** - The areas identified in Section 8 (Table 8.07) for increased maintenance and reconstruction mitigation should be continually monitored for SI decreases. Roadways where the SI decrease should be reconstructed as soon as possible.

- **Fill Haul** - Establish contingency plans for the various alternatives for bringing in the fill material (trucks, barge, and/or conveyor).

- **Traffic Diversion Model** - Prepare a diversion model for the project which includes the network as shown in Section 8 (Figure 8.01). Improvements to the arterial system as a result of diversion should be implemented prior to the start of the hauling activity on the freeways. An arterial improvement program should be implemented prior to the construction of the Third Runway.

- **Additional Traffic** - Areas identified in Section 8 (Table 8.10) should be monitored for additional traffic impacts after the Third Runway is operational.

- **Expand EIS Analysis** - The EIS traffic analysis should be expanded to the entire network as shown in Section 8 (Figure 8.01).

- **Accidents** - Develop a Freeway Incident Management Plan for the construction phase and impose operational restrictions on the heavy trucks involved with the haul

- **Regulatory Compliance** - Comply with all appropriate Federal, State and local noise regulatory requirements for surface transportation of fill and other materials associated with Master Plan Update implementation.

- **Construction Restrictions** - Restrict all construction operations, including heavy equipment and trucks hauling fill, between the hours of 7:00 AM and 9:00 PM Monday through Friday and 9:00 AM to 9:00 PM on Saturdays.

- **Noise Control Devices** - Equip all construction equipment, including trucks hauling fill, with noise control devices.

- **Complaint-Driven Requirements** - If noise complaints are received during construction, implement one or more of the following:
  - Relocate stationary construction equipment as far from nearby noise sensitive properties as possible.
  - Shut off idling equipment.
  - Re-schedule construction operations to avoid periods of noise annoyance.
  - Notify nearby residents whenever extremely noisy work will be occurring.
  - Install temporary/portable acoustic barriers around stationary construction noise sources.
  - Place material stockpiles between crushing or screening operations and the affected dwelling(s).

- **Remodeling** - When the Master Plan Update implementation is started, remodel existing surface transportation noise with the most current version of STAMINA (or the most accepted program) and compare with the 1994 existing baseline conditions and the actual conditions at the start of construction.

- **Clarify Modeled Surface Traffic Noise** - In the Integrated Noise Model, distinguish between construction and other surface traffic, in particular traffic associated with hauling fill.

Principal Socio-Economic Recommendations

The following recommendations are included in Section 9 of the study. Please refer to Section 9 for a complete description of the study's socio-economic recommendations.

- **Additional Community Services/Facilities** - Provide additional services and facilities that match the needs of the changing residential demographic in the impacted communities.

- **Additional School Services/Facilities** - Provide additional services and facilities that match the needs of the changing residential demographic in the Highline School District.

- **Property Values** - Make a partial payment of property taxes for homeowners in the five impacted cities equal to an annuity of the present value of whose payments equal the property's loss of relative value caused by expansion of the Airport. If partial tax payments are not made, then make annual off-setting payments to each of the five impacted cities to compensate them for the relative declines in residential property values caused by construction of the Third Runway and related Airport facilities.

- **Promotion of Home Ownership** - Establish a revolving "Home Ownership Loan Fund" to facilitate the movement of persons living in Burien, Des Moines, Federal Way, Normandy Park and Tukwila from "renter" to "owner" housing tenure status.

- **School Tax Revenues** - Conduct a detailed analysis of the potential shortfall in Highline School District's property tax base that will result from construction of the Third Runway and related Airport facilities.

- **Changing Student Demographic Profile** - Additional research should be undertaken to develop quantitative estimates of the relationship between demographic shifts in the Highline School District's student population, levels of student performance and appropriate mitigation measures to maintain the District's traditional quality of education outcomes.

- **Public Safety Costs** - Establish a program which reimburses the Cities of Burien, Des Moines and Tukwila for the additional public safety requirements they will experience.

- **Cultural Resources Enhancement** - Each of the five impacted cities should develop a cultural resources enhancement plan specifically directed toward meeting the quality of life challenges that the Third Runway and related Airport facilities.

- **Social Services Plan** - Each of the five impacted communities should develop a Southwest King County integrated community social service resource and delivery plan.

- **Public Health Analysis** - It is recommended that the School of Public Health at the University be funded to conduct an Airport health impact assessment, and that if the assessment finds a positive correlation between adverse health impacts and levels of Airport operation, appropriate measures to mitigate these affects be funded.

- **Environmental Justice** - Establish a monitoring system in the area to the north of the Airport under the approach/departure flight track for the Third Runway to insure that the intent of Federal Executive Order 12898, "Environmental Justice" are met.

- **Quality of Life Indicator** - Create a quality of life indicator model for the five impacted cities and for areas in Northwest King County which are appropriate as a comparison area. The model should be used to identify changes in the impacted cities' relative quality of life over time and the major quality of life indicators which contributed to the decline.

- **Airport Operations Assessment** - Conduct an economic and engineering assessment of Airport operations to determine Airport functions which would have positive economic development benefits and could be shifted to the five impacted cities.

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SECTION 1
INTRODUCTION

SECTION 1
INTRODUCTION

1.01 - INTRODUCTION

The Seattle-Tacoma (Sea-Tac) International Airport is operated by the Port of Seattle and located in the City of SeaTac, Washington, in southwestern King County. Development of a third north/south runway (8,500 feet) has been proposed in order to expand the airport's capacity. Other airside, terminal and landside improvements have also been proposed as part of the Master Plan Update for Sea-Tac.

In response to concerns regarding the potential for increased aviation-related impacts upon the neighboring communities, the State of Washington initiated a grant in 1995 to assess the impacts of the proposed Third Runway. This grant was authored by State Senator Mike Heavey and was administered through the State's Department of Community, Trade, and Economic Development (CTED). The purpose of the study was to assess the projected impacts of the proposed Third Runway and to develop mitigation strategies for the Cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital. The study area is shown in Figure 1.01.

The provisions of this State grant stipulated that the study cannot be used to oppose the proposed Third Runway at Sea-Tac International Airport. Specifically, the grant stated:

> *"State appropriation is provided solely for distribution to the City of Burien for analysis of the proposed Port of Seattle third runway, including preparation of a draft environmental impact statement and other technical studies. The amount provided in this subsection shall not be expended directly or indirectly for litigation, public relations, or for any consulting services for the purposes of opposing the construction of the proposed third runway."*

1.02 - CONSULTANT SELECTION

Acting in the capacity of the grant manager, the City of Burien coordinated the consultant selection process and worked cooperatively with the Cities of Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital. Requests for proposals were advertised both locally (metropolitan Seattle area) and nationally. A short-list of consultant teams was selected to be interviewed in November 1995. Upon conclusion of the interviews, the following firms were selected in December 1995 to conduct this study:

- **Hellmuth, Obata + Kassabaum, Inc.** (Dallas, Texas), with **Raytheon Infrastructure Services, Inc.** (Denver and Philadelphia). The HOK/Raytheon team provided environmental, transportation, and community compatibility analysis and mitigation approaches.

- **Thomas/Lane & Associates, Inc.** (Seattle, Washington) provided socio-economic analysis and mitigation measures.

- **Michael J. McCormick, AICP** (Olympia, Washington) provided inter-governmental affairs consulting.

HOK, Thomas/Lane, and Michael J. McCormick contracted individually with the City of Burien. (Raytheon provided professional consulting services as a subconsultant to HOK). The City of Burien coordinated the overall studies.

1.03 - PROJECT SCOPE

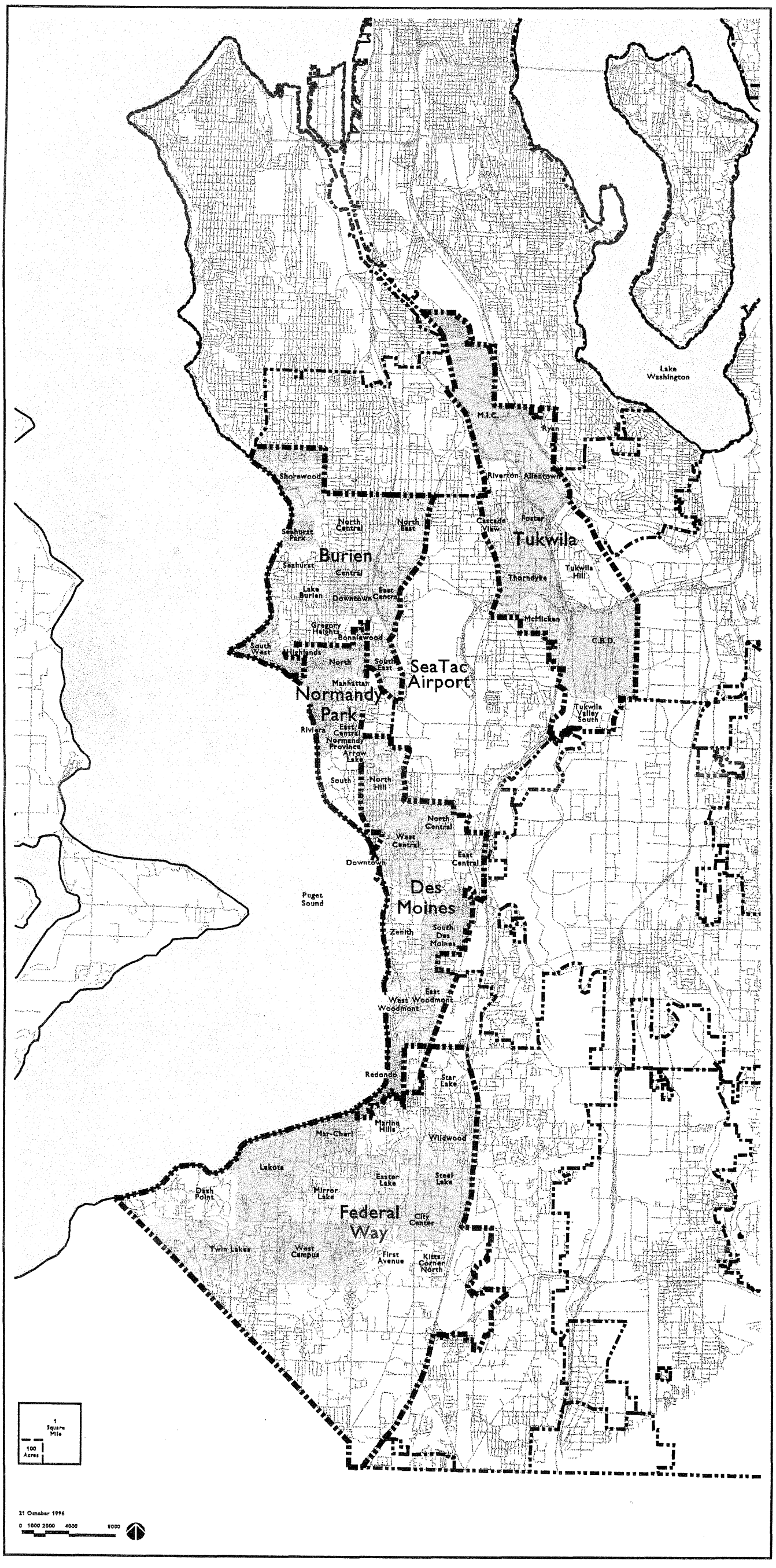
The Sea-Tac International Airport Impact Mitigation Study consisted of eight general tasks:

- **Project Initiation (Task 1)** - The consultants met with representatives of the Cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital to review the project scope and to gather base data, including information from the Federal Aviation Administration (FAA), the Port of Seattle (POS), the Sea-Tac Master Plan Update Environmental Impact Statement (EIS), and other sources of information.

- **Documentation/Discovery (Task 2)** - The consultants reviewed the information provided in Task 1, identified additional data needs, developed project base maps, and documented existing conditions.

- **Meetings, Presentations and Reviews (Task 3)** - During the course of the project, the consultants met five times in the project area and conducted informational meetings and addressed questions and comments from the Cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital. Meetings were also conducted with city councils, citizens, State and Federal agencies, and other interested parties. The consultants conducted over 100 meetings and presentations during 15-19 April 1996, 20-24 May 1996, 24-28 June 1996, 5-9 August 1996, 21-31 October 1996, and 10-20 March 1997. Project coordination meetings were conducted in Dallas with the consultants and representatives of the Cities of Burien and Federal Way on 16-20 September 1996 and 9-11 December 1996.

Figure 1.01
Study Area



- **Define Mitigation State-of-the-Art (Task 4)** - The consultants conducted a literature and Internet search and various telephone interviews to summarize airport mitigation experiences and mitigation precedents set by major projects within Washington State.

- **Environmental Analysis (Task 5)** - The consultants reviewed the Master Plan Update EIS and established a baseline for potential environmental impacts utilizing primarily existing information in the EIS and some additional data collected in Tasks 1 and 2. The potential environmental impacts were assessed and an environmental analysis technical memorandum was produced which was incorporated into the project report.

- **Traffic Analysis (Task 6)** - The consultants reviewed the Master Plan Update EIS and established a baseline for potential traffic impacts utilizing the existing information in the EIS and data collected in Tasks 1 and 2. The potential traffic impacts were assessed and a traffic analysis technical memorandum was produced which was incorporated into the project report.

- **Socio-Economic Analysis (Task 7)** - The consultants reviewed the EIS and established a baseline for projected socio-economic impacts utilizing the existing information in the EIS and data collected in Tasks 1 and 2. The potential socio-economic impacts were assessed and a socio-economic analysis technical memorandum was produced which was incorporated into the project report.

- **Mitigation Plan (Task 8)** - The consultants developed an approach to neighborhood mitigation which addressed the potential impacts of the proposed project. The draft mitigation approach was presented to city staff, citizens, the POS staff, and various State and Federal agencies for review and comment. The plan was revised and incorporated into the project report.

1.04 - PROJECT APPROACH

The approach to this study involved several assumptions:

- A basic assumption of the study was that the proposed Third Runway and associated airport improvements would be approved and constructed.

- The data developed by the Port of Seattle for the project's Environmental Impact Statement was the basis for the information to be analyzed. Additional supplemental information was provided by King County, the City of Seattle, various Washington State and Federal agencies, the Puget Sound Regional Council (PSRC), the Puget Sound Air Pollution Control Agency (PSAPCA), the study area cities, the Highline School District, and the Highline Community Hospital. No new information, data, studies, or models were generated as a component of this study.

- The proposed project at Sea-Tac International Airport consists of a new 8,500-foot north/south runway (west of the existing outboard runway) and associated terminal and capacity improvements necessary to accommodate projected airport demand through the Year 2020. This project was generally referred to as Alternative 3 in the EIS.

- The study analysis was based on individual neighborhood areas as defined by each of the five study area cities. Potential impacts were projected for each neighborhood based upon the above data. Various mitigation measures were developed to address the needs of each neighborhood, rather than just individual properties.

- Appropriate legislation from the State of Washington - specifically the Growth Management Act (GMA) and the State Environmental Policy Act (SEPA) - was utilized to evaluate and assess the mitigation necessary to address the potential impacts. The experience of other American airports and other major Washington State projects also was reviewed to determine appropriate mitigation approaches.

This report documents the consultant analysis which was conducted during the period April 1996 through February 1997. During the study, the consultants met regularly with citizens, city staff, elected officials, Highline School District and Highline Community Hospital representatives, staff from the Port of Seattle, and representatives from various city, County, regional, State, and Federal agencies.

Sections 2, 3 and 4 present an evaluation of the Environmental Impact Statement with respect to environmental (Section 2), transportation (Section 3) and socio-economic (Section 4) issues.

Sections 5 and 6 present a summary of case studies of mitigation at selected US airports (Section 5) and for major projects within Washington State (Section 6).

Sections 7, 8 and 9 project the potential impacts for the study area and propose mitigation measures for environmental impacts (Section 7), transportation impacts (Section 8) and socio-economic impacts (Section 9).

Section 10 presents a summary of the findings of this report. Several appendices are also included which address equity issues and socio-economic impacts (Appendix A), technical references (Appendix B), project contacts (Appendix C), and a glossary of terms (Appendix D).

SECTION 2

EIS ENVIRONMENTAL ANALYSIS

SECTION 2
EIS ENVIRONMENTAL ANALYSIS

2.01 - INTRODUCTION

Task 5 of the consultant scope of services focused on analysis of the Sea-Tac International Airport's EIS if Alternative 3 is implemented. The following areas were analyzed:

- Noise and vibration impacts.
- Air quality impacts.
- Impacts on water resources, water quality and hydrology, wetlands, and floodplains.
- Aesthetics and visual impacts.

For each of these areas, the scope of services involved the following:

- Evaluate the adequacy of the studies which were part of the Master Plan Update's Final EIS.
- Establish a baseline for potential project impacts.
- Assess the impacts for both project construction and operation.
- Identify issues in the EIS and recommend methodologies to enhance the analysis.

This environmental analysis will be the basis for formulating mitigation measures to minimize potential project impacts and to address the issues raised in this Section. In order to fully evaluate the appropriate areas of the EIS, each area was reviewed for the following:

- Methodology: assumptions; monitoring stations; baseline data/modeling.
- Existing conditions.
- Future conditions and impacts.
- Mitigation.

The evaluation is based on a review of the different EIS Chapters, appropriate literature information and discussions with the agencies and persons contacted. The specific EIS Chapters reviewed are shown in Table 2.01.

Table 2.01
EIS Chapters Reviewed for Environmental Issues

Chapter	Section	Title
--	--	Executive Summary
I	--	Project Background and Purpose and Need
II	--	Alternatives
III	--	Affected Environment
IV	1	Noise
IV	2	Land Use
IV	7	Human Health
IV	9	Air Quality
IV	10	Water Quality and Hydrology
IV	11	Wetlands
IV	12	Floodplains
IV	19	Earth
IV	20	Solid Waste
IV	21	Hazardous Substances
IV	23	Construction Impacts
IV	24	Aesthetics and Urban Design
V	--	Probable, Unavoidable, Adverse Environmental Impacts and Mitigation Measures
Appendix C	--	Noise Impacts
Appendix D	--	Air Pollutant Methodology
Appendix F	--	Stream Survey Report for Miller Creek
Appendix G	--	HSP-F Hydrological Modeling Analysis
Appendix H-A	--	Jurisdictional Wetland Delineation
Appendix H-B	--	Wetland Function and Values Assessment
Appendix N	--	Aesthetic Views and Photos
Appendix P	--	Natural Resource Mitigation Plan
Appendix Q	--	Water Studies
Appendix Q-A	--	Baseline Groundwater Study
Appendix Q-B	--	Preliminary Water Conservation Plan
Appendix Q-C	--	Concepts for Using a Constructed Aquifer to Manage Airport Stormwater
Appendix R	--	Responses to Public Comments

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

2.02 - NOISE AND VIBRATION

Noise and vibration issues in the EIS are discussed in Chapter IV, Sections 1, 7 and 23, Chapter V, Appendix C and part of Appendix R. In Appendix C, standard aircraft noise descriptors or metrics are described as follows:

- **LDN (Day-Night Average Sound Level)** - "LDN" is the FAA specified noise descriptor; it employs the LEQ or equivalent sound level which is a single numerical noise rating in A-weighted decibels (dBA) which would contain the same noise energy as the time-varying sound level in a given period of time; the LDN provides a numerical description of the weighted 24-hour cumulative noise energy level using the A-weighted decibel scale over one year.

- **LEQ (Average Daily Sound Level)** - "LEQ" is used to define noise exposure without the penalty of nighttime activity over a specified period of time (e.g., 24 hours, a school day); in general, the closer the 24 hour LEQ and LDN values are to each other, the less the impact of nighttime activity; if the LDN is 3 dBA or greater than the LEQ, the nighttime noise is considered to be a major contributor to the overall noise environment.

- **SEL (Sound or Single Event Exposure Level)** - "SEL" is the noise associated with a single aircraft noise event either on the ground or while in flight. Noise complaints are generally a result of a SEL.

- **TA (Threshold or Time Above)** - "TA" represents the number of minutes per average annual day that a location is exposed to noise in excess of given decibel thresholds such as 65 dBA.

These metrics are used to describe sound pressure or amplitude and sound frequency. Sound pressure is a direct measure of the sound magnitude without consideration for other factors that may influence its frequency. A standard unit of measuring sound pressure is the decibel (dB). Because the range of sound pressures in the environment is so large, these pressures are expressed on a logarithmic scale. This scale compresses the wide range in sound pressures.

Sound frequency is expressed as Hertz (Hz) or cycles per second. Young adults normally have an audible frequency range of 2 to 16,000 Hz; whereas, aircraft noise is between 50 to 5,000 Hz. The human ear has different sensitivities to various frequencies, with some louder or quieter than others. Thus, methods for frequency weighting have been developed with the most common being the A-weighted noise curve or dBA. The A-weighted scale performs this compensation by discriminating against frequencies similar to the human ear. All Federal agencies dealing with community noise use the A-weighted sound level as the basic unit for environmental impact analysis.

In the EIS, it is indicated that noise levels in flight are regulated by the FAA's aircraft certification process. Certain non-flight activity at the Airport is regulated by state and local regulations.

Chapter 173-60 of the Washington Administrative Code (WAC) specifies maximum noise levels that one property can project onto another. However, under the code the following are exempt:

- Sounds created by aircraft engine testing and maintenance not related to flight operations between 7:00 AM and 10:00 PM, provided that testing and maintenance is conducted at a remote site, whenever possible.

- Sounds originating from aircraft in flight and sounds that originate at airports which are directly related to flight operations.

Therefore, the WAC applies only to aircraft engine testing and maintenance at night which are not related to flight activity.

King County has adopted the WAC regulations within their areas of jurisdiction as shown in Table 2.02.

Table 2.02
King County Maximum Permissible Noise Levels

Land Use Zone of Noise Source	Land Use of Receiving Property/dBA			
	Rural	Residential	Commercial	Industrial
Rural	49	52	55	57
Residential	52	55	57	60
Commercial	55	57	60	65
Industrial	57	60	65	70

(Source: Washington Administrative Code, March 1987)

The maximum permissible noise levels are:

- Reduced by 10 dBA at night (10:00 PM to 7:00 AM) when the receiving land use zone is residential.

- Reduced by 5 dBA at night for sounds that are periodic or contain pure tones..

- Increased by 15 dBA for up to 1.5 minutes, 10 dBA for up to 5 minutes, 5 dBA for up to 15 minutes (all per hour) for noises of short duration.

The US Environmental Protection Agency (USEPA) has identified the 55 LDN as the desirable noise level for protecting the public health and welfare with an adequate margin of safety (EPA, March 1974).

This is not a regulatory level, but as indicated by the Puget Sound Regional Council and Port of Seattle (October 1992):

> *"... the 55 LDN is indicative of a desired goal for the noise environment within the communities of the Puget Sound Region."*

2.03 - AIRCRAFT NOISE EFFECTS METHODOLOGY

In the EIS, aircraft noise effects represented:

> *"... the land area and number of people and residences above predetermined levels."*

These levels were defined by LDN (Day-Night Average Sound Level) contours of 60, 65, 70 and 75 LDN.

The LDN contours were developed by using FAA's Integrated Noise Model (INM), Version 4.11. This model version includes information on:

- Aircraft fleet mix.
- Flight track and runway use statistics.
- Flight profiles adjusted for ,local elevation and temperature.
- Aircraft ground activity including taxi movement noise and aircraft run-up noise.
- Ground terrain.

Each contour developed for the EIS assumes that the existing noise abatement program summarized below, will remain in effect in the future. The FAA considers airport noise impacts to be significant if the LDN noise levels increase 1.5 dBA or more within the 65 LDN noise contour.

In the United States, two computer-based noise simulation models are currently used which produce LDN contours. The INM was developed by the FAA and is most often used for civil airports; whereas, NOISEMAP was developed by the US Air Force and is generally used for military air bases. Thus, the INM, Version 4.11, was an appropriate model to use and was the latest version of the INM at the time the EIS was developed. Since the EIS was developed, two updated versions of the INM have been developed:

- **INM Version 5.0** - Version 5.0 is a Windows-based program which was released in August 1995. It included such enhancements as a new graphics user interface, new data preparation and input aids, new graphics and plotting capabilities, and improved and faster noise calculations algorithms. More accurate noise predictions also are supposed to be made.

- **INM Version 5.1** - Version 5.1 is a Windows '95-based program which was released in late 1996. It has the ability to plot noise contours on a street map and has an expanded data base of aircraft including the Boeing 777 and MD-90. At the time the EIS was done, noise data for a Boeing 767-200 with JJ-9-D was substituted for the Boeing 777 aircraft.

Because of at least the greater accuracy of the INM, Version 5.1 - the ability to plot noise contours on a street map and the expanded data base of aircraft information - the noise model should be rerun using Version 5.1. This will allow confirmation of the data from INM, Version 4.11 and the most up-to-date information available on the newer aircraft noise characteristics. The noise study did not include an extensive evaluation of sound exposure level (SEL). According to Horonjeff and McKelvey (1994):

> *"In addition to LDN contours, SEL contours can be helpful in addressing issues of sleep and speech interference and for analyzing the effects of noise abatement procedures, such as proposed noise abatement flight tracks. Graphical comparisons of SEL contours of various aircraft types can also provide powerful images for comparing noise emissions of different aircraft types."*

They also indicate that:

> *"Tabular listings for user-specified ground locations show not only the predicted LDN but also the SEL and LDN contribution of individual aircraft by runway and flight corridor. This information is invaluable to understanding the major contributors to the total LDN. It can also be used to compare the model predictions with data from noise-monitoring locations. Such comparisons often provide the basis for fine-tuning model inputs as well as promoting public confidence in the computer model and the contours it produces."*

In the EIS, the INM was used to show the SEL contours for one approach to Runway 16R and one departure from Runway 16L for five aircraft types which dominate the current and future fleet mixes at the Airport. Based on the comments by Horonjeff and McKelvey (1994), it appears as if it would be useful to have a more extensive discussion of the SEL contours; their relationship to the LDN contours; and their relationship to health problems, in particular, sleep and speech interference. Thus, this should be done concurrent with re-evaluating the noise data using INM, Version 5.1.

The EIS for the Flight Plan Project (Puget Sound Regional Council and Port of Seattle, October 1992), included noise assessment information associated with the 55 LDN level and a SEL of 80 dBA. This SEL was selected because it is often used to supplement the LDN analysis and 80 dBA corresponds to the level at which sleep disturbance and speech interference start to occur. This EIS used the following overall noise assessment criteria in the analysis:

- Population exposed to cumulative noise levels in excess of 55 LDN.
- Population that would be newly exposed to cumulative noise levels in excess of 55 LDN.
- Population exposed to cumulative noise levels in excess of 65 LDN.
- Population that would be newly exposed to cumulative noise levels in excess of 65 LDN.
- Population that would be exposed to single event SEL noise levels in excess of 80 dBA.

The assessment criteria related to the 65 LDN were used in the Master Plan Update Alternative EIS; but the other criteria were not. Since the Flight Plan Project included the proposed Third Runway as an Airport capacity enhancement measure, the results of this EIS and assessment criteria should have been included in the Master Plan Update EIS. A more detailed evaluation of the SEL information would be particularly relevant since the information in EIS Table C-28 shows numerous receptors with peak levels above 80 SEL. In Appendix R of the EIS, it is indicated that computation of noise contours below 60 LDN is unreliable using the INM. Thus, a combination of noise measurement methods may be required to evaluate population exposure at the 55 LDN. This will, in part, depend upon INM, Version 5.1 capabilities.

The EIS approach to aircraft noise focused mostly on flight noise impacts taking into consideration run-up noise and aircraft taxing noise. The South Aviation Support Area EIS used the previously mentioned NOISEMAP model to also look at aircraft run-up and taxing operations (US Department of Transportation, Federal Aviation Administration and Port of Seattle, March 1994). It would have been useful if this information also had been developed and discussed for the Master Plan Update implementation EIS. The run-up evaluation should include a discussion of line maintenance run-ups, base maintenance run-ups and run-up locations with particular reference to the proposed Third Runway and facilities proposed as part of Master Plan Update implementation.

Appendix C Noise impacts in the EIS indicates that existing aircraft operations were based on average daily operations. It is not completely clear how many operations per hour this equates to. The air quality analysis used an aircraft peak hour activity level of about 88 operations (43.9 arrivals and 43.9 departures). The relationship, if any, between the noise and air quality aircraft operations or activity levels should be explained better taking into consideration the noise and air quality analyses used the August and June 1994 Official Airline Guide (OAG), respectively. Also, the discussion should include comments on the Airport being able to accommodate 60 arrivals per hour which was recently mentioned by the Port of Seattle (26 March 1996; 1 August 1996).

Existing Conditions

The FAA has established the 65 LDN as the critical level for the determination of noise impacts. The 60 LDN level was provided in the EIS for information only to allow a better understanding of aircraft noise levels in the Airport area. It is of interest to note that for the Flight Plan Project EIS (Puget Sound Regional Council and Port of Seattle, October 1992), the 55 LDN level was used as one of the noise assessment criteria. In this EIS, it was observed that:

"A noise level of 55 LDN and greater indicates the population to which the aircraft noise will be noticeable and some degree of annoyance or adverse community response would be expected to occur. Experience at Sea-Tac showed most areas (but not all) where noise complaints occurred were exposed to LDN levels of 55 or greater. For a new airport site, the 55 LDN represents that area in which future residential land use development may consider land use zoning, and other land use control measures to avoid significant noise-related residential land use impacts."

Based on the 65 LDN contour the following was concluded in the EIS for the Master Plan Update implementation:

- This contour includes 12.23 square miles.

- The 65 LDN noise exposure contour extends from north to south from the Duwamish River (just south of the Boeing Field Plant to near 280th Street South); to the west of the Airport the contour tapers to the southeast from the vicinity of 188th Street and 8th Avenue to its southern end; to the east and north of the Airport the noise contour is generally east of and parallel to State Route 509; east and west of the runway ends, the contour bulges outward which reflects the areas from thrust at takeoff to begin the role for departing flights; the contour between the runway ends curves in toward the Airport.

- Approximately 31,800 people in 13,620 homes are impacted by noise levels 65 LDN and greater; this represents a 52% reduction in population exposure over the 1991 conditions.

- The predominant use of the southerly traffic flow and the prevailing winds results in the largest portion of the 65 LDN contour falling south of the Airport.

- Because of increased thrust levels during take-off, noise levels are several decibels higher than approaches and noise contours extend further into communities south of the Airport.

- When traffic is in south flow, the east parallel Runway 16L is used for most departures and the west Runway 16R is used for most arrivals; when traffic is in north flow, Runways 34L and 34R (west and east runways) are used for departures and approaches, respectively; the noise exposure contours show greater exposure along the centerline of the approaches to Runways 16R and 34R.

The existing runway utilization is shown in Table 2.03.

Based on a visual examination of the data and results for the existing conditions description, it appears as if the results are appropriate for INM, Version 4.11. As indicated above, the results of this analysis should be compared with data generated by the INM, Version 5.1. In addition, the existing conditions description should include a better discussion of the relationship between the LDN, SEL and TA calculations and contours. The EIS indicates that TA:

"... is helpful in determining the exposure of certain noise sensitive users (schools, sleeping quarters, etc.) to extended periods of noise at various levels which may be disruptive to the activity occurring there."

However, the EIS did not address in detail the TA or other noise metrics issues with respect to these sensitive receptors. As part of checking the noise contours generated by the INM, a comparison was made with the measured noise level at the eleven existing noise monitoring stations. The comparison indicated a relative close relationship between the INM and actual measured data.

Table 2.03
Existing Runway Utilization

Runway	Aircraft Category[a]	Arrivals Day[b]	Arrivals Night	Departures Day	Departures Night
South Traffic Flow - 65%					
16L	Heavy	17.7%	1.73%	62.6%	47.3%
	Jets	13.2%	20.0%	56.5%	58.2%
	Props	19.1%	29.4%	58.6%	57.1%
16R	Heavy	47.3%	47.7%	2.4%	17.7%
	Jets	51.8%	45.0%	8.5%	6.8%
	Props	45.9%	35.6%	6.4%	7.9%
North Traffic Flow: 35%					
34L	Heavy	2.2%	0.0%	21.0%	21.0%
	Jets	7.0%	8.4%	30.0%	29.9%
	Props	13.0%	8.8%	24.8%	27.4%
34L	Heavy	32.8%	35.0%	14.0%	14.0%
	Jets	28.0%	26.6%	5.0%	5.1%
	Props	22.0%	26.3%	10.2%	7.6%

A - Aircraft category use as follows: Heavy (jet-powered aircraft with a takeoff weight of 300,000 or more); Jets (jet-powered aircraft with a takeoff weight of less than 300,000 pounds); Props (all piston or turboprop-powered aircraft).
B - "Day" indicates 7:00 AM to 9:59 PM. "Night" indicates 10:00 PM to 6:59 AM.

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

However, in Appendix R of the EIS, it is indicated that:

"Noise monitoring sites are not sufficient in numbers and are not located at distances far enough from the Airport to be used in the delineation of the noise exposure contours. Although there are sufficient sites near the Airport to provide information for input adjustment, the absence of sites at greater distance preclude the full array of data necessary for the modification of input information."

Based on this, it appears as if the number of permanent noise monitoring stations is inadequate and should be increased to help validate the INM noise contours.

In addition, the noise monitoring stations have inadequate coverage of the area surrounding the Airport, in particular, to the northwest, west, southwest and northeast of the Airport. The need for more monitoring stations will become particularly important as a result of Airport activities moving approximately 1/2 mile west with Master Plan Update implementation. As part of adding more noise monitoring stations, the system also should be upgraded to replace old noise monitoring equipment.

It should be noted that the Port of Seattle is currently evaluating the need for additional monitoring stations and upgrading their equipment (Port of Seattle, 1 August 1996). Representatives from the cities and concerned groups/citizens in the Airport area should participate with the Port of Seattle in the selection of appropriate monitoring sites that are not limited primarily to the north/south flight paths.

As part of the existing conditions discussion, the EIS provides information on the aircraft noise reduction/abatement programs. These include:

- **Noise Budget Program** - The Airport will move toward an all Stage 3 aircraft fleet by limiting the amount of noise airlines are allowed to make each year; the goal agreed to in the Noise Mediation Agreement (Port of Seattle and Mestre Greve Associates, 31 March 1990) is to reduce noise by the Year 2001.

- **Nighttime Limitations Program** - This program involves phasing out Stage 2 aircraft during nighttime hours; effective 1 October 1995, Stage 2 jet aircraft may not operate between 10:00 PM and 7:00 AM unless granted an exemption or variance (e.g., delays due to weather, air traffic control delays, etc.).

- **Ground Noise Control Program** - Airplanes are not allowed to back away from gates using engine power, instead they must be pushed away by "tugs"; run-ups during the daytime are allowed only at designated locations on the north and south ends of the Airport (aircraft must face into the wind so that jet blast is directed back across the airfield); between 10:00 PM and 7:00 AM run-ups are allowed only under special circumstances such as for a departure.

- **Overflight Noise Abatement Procedures** - Initial "straight-out" departure corridors are in a narrow flight path; Duwamish/Elliot Bay corridor for arriving and departing flights keep aircraft over water and industrial areas as much as possible; nighttime procedures to keep flights over Puget Sound waters as much as possible.

- **Flight Path Monitoring** - The Airport's Noise Abatement Office monitors jet flights in the noise abatement corridors.

- **Noise Monitoring** - Eleven station permanent noise monitoring system to record noise exposure levels in the Airport area.

- **24-Hour Noise Information Line** - Provides information on noise issues or accepts noise complaints.

In Appendix R of the EIS, it is indicated that the nighttime noise budget and limitations program is designed to address noise issues associated with aircraft categorized as having FAR Part 36 Stage 2 noise levels. Therefore, the program will expire with the completion of the scheduled phase out of these aircraft between 2000 and 2003. These two components are an integral part of the aircraft noise reduction/abatement programs and discussions should be held with the Port of Seattle about continuing the implementation of the nighttime limitations program beyond the Stage 2 phase out schedule. Depending on the status of the nighttime noise budget program in relation to Stage 3 aircraft, this program also should be continually evaluated and updated based on the different stages of aircraft.

INM Version 4.11 has the capability to compute noise levels due to airplane engine run-up operations. This is particularly useful for noise information around airplane maintenance facilities. Because concern has been expressed about noise levels associated with existing run-up and maintenance operations, and the proposed south aviation support area activities, a discussion of this feature and data for the Sea-Tac International Airport would be useful. This information should be provided for both the existing and future conditions.

Future Conditions

Future conditions were based on the following average day operations:

- Year 2000 - 1.038 average daily operations.
- Year 2010 - 1,112 average daily operations.
- Year 2020 - 1,210 average daily operations.

Based on these operations, the runway utilization was predicted as shown in Table 2.04 with Runways 16X and 34X indicating the south and north flow, respectively, on the new Third Runway. This utilization reflects the requirements for Stage 3 aircraft.

Under the future development condition flight tracks are not expected to differ from the existing flight tracks. These flight tracks also were duplicated for the new Third Runway 16X (south flow) and 34X (north flow). Conclusions concerning the future conditions were as follows:

- Alternative 3 and the other project alternatives would result in an increase of 5% to 7% in the 65 LDN noise exposure area over the "Do-Nothing" alternative.

- The length of the new runway would have little effect on the area within the noise pattern.

- The noise exposure pattern of each future alternative would be 42% to 50% smaller than the pattern of the existing condition.

- Of the 1,252 sites where LDN levels were computed, 33 sites would experience significant increases in the Year 2000, 40 in the Year 2010, and 47 in the 2020 with "significant" defined as a 1.5 LDN increase in aircraft noise.

- Aircraft noise levels of 65 LDN and greater would impact the following areas for Alternative 3:

  - Year 2000 - 2.86 square miles, 4,020 dwelling units, 9,890 persons.
  - Year 2010 - 2.98 square miles, 4,190 dwelling units, 9,860 persons.
  - Year 2020 - 3.34 square miles, 4,740 dwelling units, 11,240 persons.

Table 2.04
Future Runway Utilization

Runway	Arrivals	Departures
South Traffic Flow - 63.9%		
Runway 16L	31.9%	23.7%
Runway 16R	19.9%	37.6%
Runway 16X	12.1%	2.6%
North Traffic Flow - 35.1%		
Runway 16L	17.5%	14.2%
Runway 16R	15.3%	20.6%
Runway 16X	3.3%	1.3%

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

Based on the review of the information presented in the EIS for the future conditions, the information appears reasonable. As part of the Final Decision on Noise Issues (Puget Sound Regional Council, 27 March 1996), the expert noise arbitration panel indicated that with respect to the INM, a number of assumptions must be made which can affect the outcome. Sensitivity tests can be used to evaluate how much change in a key input value or assumption might affect the outcome. A similar approach would be useful in evaluating the assumptions used in the future noise modeling and the resultant data. Thus, sensitivity tests should be conducted and evaluated. Also, if possible, information on the range and standard deviations of the LDN and other data in the EIS should be presented. The range and standard deviations of the data could provide an indication of potential impacts beyond the noise contours shown in the EIS.

As discussed in EIS Appendix R (and as previously mentioned), actual noise information for the Boeing 777 was not available and alternate information was used. The INM, Version 5.1 should be used to re-evaluate the future noise contours since it is supposed to contain this information.

The noise mediation agreement (Port of Seattle and Mestre Greve Associates, 31 March 1990) indicates that as technology with noise barriers develops, the Port of Seattle will evaluate their use. It is not clear if during the future conditions evaluation the use of noise barriers was

included. This may be particularly useful in the vicinity of any new maintenance facilities in addition to the use of "hushing" equipment. Appendix R of the EIS also mentions the use of vegetation to help reduce noise. The EIS indicates in Chapter 1 that as part of the Master Plan Update objectives, Airport noise is to be attenuated through the use of berms and barriers (Port of Seattle, May 1994).

2.04 - SURFACE TRANSPORTATION NOISE EFFECTS

Surface transportation noise effects focused on the noise issues associated with the proposed surface transportation.

Methodology

For this analysis, the Federal Highway Administration (FHWA) computer program STAMINA 2.0 was used. The model calculated roadway noise levels at 108 user-specified receivers. The input to the model included:

- **Roadway Description** - Sets of roadway requests were defined within a network of sixteen area thoroughfares.

- **Traffic Volume** - Traffic on each of the major roadway requests during the peak hour of the day was evaluated based on final Metropolitan Transportation Plan traffic volumes which were updated.

- **Vehicle Classification** - Proportion of vehicle type, passenger cars, medium trucks and heavy trucks.

- **Travel Speeds** - For minor arterial roads travel speeds were assumed to be equal to the posted speed limit; for major roads including freeways, theoretical speeds were obtained by performing capacity analysis calculations, which correspond to the traffic conditions on the road link; this procedure followed the techniques contained in the Highway Capacity Manual (Transportation Research Board, 1985).

The receiver locations modeled were approximately 50 to 500 feet from a road edge in noise sensitive residential areas or facilities. The selection of these locations was coordinated with the aircraft noise analysis.

The STAMINA program produces peak hour LEQ levels for each receiver location. A LEQ is approximately 3 to 4 decibels less than a LDN.

Noise levels were calculated for the base year, 1994 and compared to ambient noise measurements conducted as part of the State Route 509/South Access Road Corridor EIS Phase II Study. Following this comparison, the STAMINA model was calibrated to more closely represent existing conditions.

Use of the FHWA STAMINA 2.0 program was appropriate for the surface transportation noise effects study. The data which was used in the model based on the information in the EIS, also seems reasonable.

Existing Conditions

The following summarizes the existing transportation/road noise conditions:

- Peak hour surface traffic noise levels range from 48.5 to 73.5 dBA LEQ (peak-hr).
- Thirty-five sites were identified as being noise impacted according to the FHWA sensitivity criterion of 67 dBA or greater.
- A total of 51 sites experience a LEQ (peak-hr) in excess of 65 dBA.
- The highest noise levels are generally located along SR 518, SR 509, IH-5/Military Road South 154th Way, and International Boulevard.

The existing conditions of the roadway noise evaluation appears to be adequate and provides a good start from which to predict and evaluate future changes. Depending on when the Master Plan Update implementation is started, consideration should be given to remodeling the surface transportation noise with the then current version of STAMINA or the most accepted program. This will allow a comparison with the 1994 existing baseline conditions and the actual conditions at the start of construction. In order to plan for this re-evaluation, the following should be done:

- Specific roadway noise monitoring sites should be established at key locations, possibly some of the sites identified as being noise impacted by the FHWA noise sensitivity criterion; the locations of these sites should be coordinated with the establishment of additional aircraft noise monitoring sites; data collection from these noise monitoring sites should begin as soon as possible in order to provide up-to-date baseline information before Master Plan Update implementation construction starts; and,
- More accurate traffic information should be obtained for the roads in the Airport area (e.g., vehicle categories and road use); the EIS indicates that relevant data was available only on IH-5 and International Boulevard for surveys conducted on 3 August 1987; 8 July 1991; and 25 February 1992.

Future Conditions

For the "Do-Nothing" Alternative, the transportation analysis indicates that noise levels will continue to be in excess of 65 dBA at the existing locations plus the following:

- By the Year 2000 five additional sites would exceed the peak hour LEQ noise level of 65 dBA; these sites will be along Kent-Des Moines Road west of International Boulevard and along South 200th Street east of International Boulevard; increases at these sites would be 2 to 3 dBA.

- In the Year 2010 noise levels at the 108 receptor sites will range from 50.8 to 74.8 dBA LEQ (peak-hr); eight additional sites would exceed the 65 dBA sensitivity level; all new sites will be located on major arterials such as South 154th Way, Des Moines Memorial Drive South, South 160th Street/Military Road, and South 200th Street; all increases are less than 2 dBA increase over 2000 levels, except for along South 24th Avenue which is 2.7 dBA.

- By 2020, 71 of the 108 receptor sites will experience LEQ (peak-hr) sound levels in excess of 65 dBA; 57 sites will experience sound levels at or above the FHWA level of 67 dBA LEQ (peak-hr); noise levels would range from 54.1 to 74.7 dBA LEQ (peak-hr); the greatest roadway related noise increases would occur along the new State Route 509/South Access Road.

A comparison between the "Do-Nothing" alternative and Alternative 3 indicates that:

- In the Year 2000 the greatest increase in noise of 4.7 dBA LEQ (peak-hr) would occur in the vicinity of one receptor at 8th Avenue South, north of SR 518; other noise receptors generally had levels similar to or below the "Do-Nothing" alternative.

- In the Year 2010 the 8th Avenue South location exceeds the "Do-Nothing" alternative location noise level by 2.3 dBA LEQ (peak-hr); other noise levels at receptor sites generally continue to be below or at the "Do-Nothing" alternative levels.

- By the Year 2020 the 8th Avenue South receptor is 0.6 dBA LEQ (peak-hr) below the "Do-Nothing" alternative and other receptor sites continue to be at or below the some "Do-Nothing" alternative noise levels.

The traffic analysis also used the STAMINA 2.0 model to evaluate earthwork and site preparation activities noise levels. Information was provided on typical noise levels of different types of construction equipment. It was indicated that based on the fill haul routes discussed in the EIS, noise levels will increase as follows on the indicated streets:

- 200th Street - 5.5 dBA.
- Des Moines Memorial Drive between 200th Street and SR 509 - 3.6 dBA.
- 24th Street near 154th Street - 6.4 dBA.
- South 160th Street east of the SR 509 interchange - 7.6 dBA.

According to the State of Washington Department of Transportation, because these noise increases are temporary, they are not subject to their noise level criterion during the daytime. They are subject to the criterion between 10:00 PM and 7:00 AM and the Port of Seattle has indicated that the Construction and Earthwork Management Plan will include steps to minimize nighttime noise impacts along the haul routes. However, area residents west of the earthwork activities for the Third Runway will experience construction related noise.

The future conditions for the roadway impact analysis was adequate based on the information available and assumptions used. Like the existing conditions analysis, it is recommended that the future analysis be evaluated again in order to reflect more accurately the information available prior to the start of construction for Master Plan Update implementation. This, is in part, to reflect more accurately actual Sea-Tac International Airport area traffic information due to growth, changes in any traffic patterns, etc. The re-evaluation would benefit from the following:

- More accurate information on construction activities, in particular haul routes, so that construction traffic can be included in the roadway noise re-evaluation.
- More accurate information on vehicle classification and their use of the various roadways.
- The additional monitoring data obtained from the roadway noise monitoring sites.

The re-evaluated future conditions discussion also should include information on the relationship between Master Plan Update implementation and the Port of Seattle's ability to maintain its Airport's reduced noise level goals. This discussion is particularly relevant because of the recent concerns about the Port of Seattle not sufficiently reducing on-the-ground noise impacts by 1 April 1996 (Puget Sound Regional Council, 27 March 1996).

2.05 - VIBRATION

The EIS vibration analysis was qualitative. A comparison was made between decibel levels recorded in the frequencies between 1 and 80 Hertz (Hz) for several different aircraft currently operating at the Airport. The range of low frequency noise levels for Stage 2 and 3 aircraft were as follows:

- **Stage 2** - 75-90 dBA (takeoff), 70-85 dBA (climb-out), 61-70 dBA (approach).
- **Stage 3** - 66-84 dBA (takeoff), 65-78 dBA (climb-out), 53-71 dBA (approach).

Based on this comparison, it was concluded that the intensities of vibration will decline as the aircraft fleet becomes entirely Stage 3. This is because the decibel levels at the low frequency levels associated with vibration are less for the aircraft that will makeup the future fleet at the Airport.

This vibration analysis was cursory and was more of a qualitative than a quantitative approach. A more extensive evaluation should be done because of the numerous complaints about vibration from aircraft activities, in particular, in homes and schools. Some of these complaints have been reported in areas such as on 160th Street and 10th, where noise/ vibration impacts will move closer with construction of the Third Runway.

More information on vibration should be presented because, "These induced vibrations - caused by airborne sound or transmitted through ground or structures - may generate additional annoyance, beyond that due to simple audibility of the impulse, because of "house rattling" and "startle," as well as additional contributions to interference with speech or sleep" (Committee on Hearing, Bioacoustics and Biomechanics, Assembly of Behavioral and Social Sciences, and The National Research Council, 1977).

Vibration should be evaluated qualitatively and quantitatively for at least the following for residences, schools and hospitals:

- Human whole body vibration.
- Annoyance and interference to humans caused by building vibration.
- Building structural damage.

With respect to humans, the evaluation should look at impacts on working efficiency, health, safety and comfort. The evaluation should incorporate the information and methodology discussed by the International Organization for Standardization (ISO; International Organization for Standardization, 1985 a and b; 1989).

Cumulative Impacts

The cumulative impact discussion for noise indicated that until specific project plans are completed for several other developments, total cumulative impacts can not be developed. Thus, only the State Route 509/South Airport Access Road development was included in the Year 2020 "Do-Nothing" and other alternatives roadway noise analysis.

This was a cursory approach to discussing cumulative impacts. At least tentative plans for these other developments should be discussed with respect to Airport Master Plan Update implementation. Therefore, the cumulative impacts evaluation should be redone and re-evaluated.

Mitigation Measures

The EIS indicates that all noise mitigation measures currently in effect to reduce aircraft noise levels will be continued. This includes the previously mentioned noise abatement programs plus the following:

- Insulation treatment of homes.

- Home sales assistance in the most severely noise impacted areas to make sure that homes sell at fair market value based upon a Port of Seattle hired independent appraiser.

- Insulation of schools, health facilities and churches.

A home acquisition and relocation program was concluded in 1993. This program was conducted from 1974 to 1993 during which the Port of Seattle acquired 1,300 homes and relocated approximately 3,900 residents. Additional mitigation measures discussed in this Section include the need to improve and expand the Airport and road noise monitoring sites to obtain more information on area noise levels. These and other mitigation measures will be discussed in Section 9. It should be noted that the Port of Seattle (1 August 1996) in its Resolution No. 3212 calls for the following:

- Working with the FAA and airlines to continue various noise reduction practices and to evaluate potential additional actions.

- Seeking commitment from the FAA to evaluate actions needed to prevent apparent violations of the north flow nighttime departure noise abatement procedures.

- Working with communities and Airport users to update the Federal Aviation Regulation (FAR) ISO Noise Compatibility Plan.

- Working with the Highline School District to insulate public schools.

- Completing "sensitive-use" public buildings and multi-family home insulation pilot programs.

- Designing and implementing a noise compatible land use plan for Port of Seattle properties within the current noise acquisition area.

- Reviewing methods for mitigating the impacts of low frequency noise and vibration.

- Upgrading the permanent noise monitoring sites from eleven to approximately twenty-five monitoring sites by the end of 1998 (data will include LDN, SEL and TA metrics).

2.06 - AIR QUALITY

Air quality issues associated with current Airport operations and the proposed Master Plan Update improvements are of major concern to the surrounding areas. This is, in part, due to the close proximity to the Airport to numerous residential neighborhoods. Implementation of the proposed improvements, in particular, construction of the Third Runway, also will bring these issues closer to the businesses along First Avenue in the City of Burien and along the southwestern part of 188th Street in the City of SeaTac.

EIS Chapter IV, Sections 7, 9 and 23, Chapter V, Appendix D, and part of Appendix R, focus on the air quality issues of the proposed Master Plan Update improvements.

It should be noted that more than one regulatory agency is responsible for air quality issues in the Puget Sound region. Three agencies have jurisdiction: US Environmental Protection Agency (USEPA); Puget Sound Air Pollution Control Authority (PSAPCA); and Washington State Department of Ecology (DOE). Their functions are as follows:

- **USEPA** - Has established the National Ambient Air Quality Standards (NAAQS) for six criteria pollutants (ozone, carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide and lead); air quality standards specify the maximum short-term and long-term concentrates of air contaminants; and EPA sets aircraft emissions standards.

- **PSAPCA and DOE** - Have state and local ambient air quality standards (AAQS) that are at least as stringent as the national standards; and operate thirty-two permanent air quality/meteorology monitoring stations in the Seattle-Tacoma Puget Sound area including seasonal stations (Puget Sound Air Pollution Control Agency, October 1995). EPA, Washington State and Puget Sound AAQS are shown in Table 2.05.

- **PSAPCA** - The primary agency for air quality in the region; responsible for enforcement of federal, state and local air quality standards for stationary sources; and responsible for developing plans and programs to attain and maintain NAAQS.

As indicated above, EPA has a NAAQS for particulate matter or PM. The current EPA standard for PM is 10 microns or less (i.e., PM_{10}) and for a 24-hour average is not to exceed 150 micrograms per cubic meter or an annual average not to exceed 50 micrograms per cubic meter as shown in Table 2.05. EPA is reevaluating the PM standard and may promulgate new standards which retain the PM_{10} standard and set a new $PM_{2.5}$ standard.

Research indicates that large particulate matter is cleared off by the lungs. However, smaller particulate matter, 10 microns or less, go deeper into the lungs and cause the most damage. This includes increased respiratory problems, short term mortality from specific air pollution episodes and long term mortality.

The EPA Office of Air Quality Planning and Standards has proposed that the 24-hour $PM_{2.5}$ standard be somewhere between 18 and 65 micrograms per cubic meter; the annual standard would be between 12.5 and 20 micrograms per cubic meter. The annual PM_{10} standard would be retained and would be between 40 to 50 micrograms per cubic meter.

Table 2.05
Ambient Air Quality Standards

Pollutant[a]	National		Washington State	Puget Sound Region
	Primary	Secondary		
Carbon Monoxide				
8 hour average	9 ppm[b]	N/A[b]	9 ppm	9 ppm
1 hour average	35 ppm	N/A	35 ppm	35 ppm
Particulate Matter (PM_{10})				
Annual arithmetic ave.[c]	50 $\mu g/m^3$[(b)]	50 $\mu g/m^3$	50 $\mu g/m^3$	50 $\mu g/m^3$
24 hour average[d]	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$
Particulate Matter (TSP)				
Annual geometric average	N/A	N/A	60 $\mu g/m^3$	60 $\mu g/m^3$
24 hour average	N/A	N/A	150 $\mu g/m^3$	150 $\mu g/m^3$
Ozone				
1 hour average[e]	0.12 ppm	0.12 ppm	0.12 ppm	0.12 ppm
Sulfur Dioxide				
Annual average[f]	0.03 ppm	N/A	0.02 ppm	0.02 ppm
30 day average	N/A	N/A	N/A	0.04 ppm
24 hour average	0.14 ppm[h]	N/A	0.10 ppm[h]	0.10 ppm[f]
3 hour average	N/A	0.05 ppm	N/A	N/A
1 hour average[g]	N/A	N/A	0.25 ppm	0.25 ppm
1 hour average	N/A	N/A	0.40 ppm[h]	0.40 ppm[f]
Lead				
Calendar quarter average[f]	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$	N/A	1.5 $\mu g/m^3$
Nitrogen Dioxide				
Annual average[f]	0.053 ppm	0.053 ppm	0.053 ppm	0.053 ppm

a Annual, quarter and 30 day pollutant standards are never to be exceeded; short term standards are not to be exceeded more than once per year unless noted.

b ppm = parts per million; $\mu g/m^3$ = micrograms per cubic meter; N/A = no applicable standard.

c Standard attained when the expected annual arithmetic mean concentrations is less than or equal to 50 $\mu g/m^3$.

d Standard attained when the expected number of days per calendar year with a 24 hour average concentration above 150 $\mu g/m^3$ is equal to or less than one.

e Standard attained when expected number of days per calendar year with maximum hourly average concentration above 0.12 ppm is equal to or less than one.

f Never to be exceeded.

g Not to be exceeded more than twice in seven consecutive days.

h Not to be exceeded more than once a year.

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

Methodology

In order to determine Airport Master Plan Update implementation potential construction and operation impacts, the air quality analysis involved the following:

- Preparation of airport emissions inventory using the Federal Aviation Administration's (FAA) Emissions and Dispersion Modeling System (EDMS) computer model.
- Area dispersion analysis using EDMS.
- Airport roadway intersection dispersion analysis using the CAL3QHC air quality computer model.
- Human health - air toxics evaluation.
- Construction vehicles air quality analysis using the CAL3QHC model.
- Clean Air Act conformity.
- Certification for compliance with air quality standards.

The methodology for each of these is evaluated below followed by information on results in the *Air Quality Results* section.

Airport Emissions Inventory

The FAA's EDMS computer model Version 944 was used to perform the air emissions inventory. Use of this model was confirmed with the EPA, PSAPCA and DOE. Aircraft and vehicle emission rates are included in the EDMS model and are based on information provided in EPA technical reports: Compilation of Air Pollutant Emission Factors (AP-42) and Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. The EDMS model also includes vehicle emission factors provided through an EPA mobile source emission program, MOBILE5A.

As indicated above, the EDMS model includes information provided by AP-42. However, during the course of this evaluation, public comments were made indicating that AP-42 emissions data may not have been consistently used, in particular with respect to particulates. It also was indicated that there may not have been particulate data within EDMS and it may have been removed from the model.

The Airport emissions inventory is used to summarize the total quantity of each pollutant from Airport activity within a defined area. The EIS indicates that this is not comparable to ambient air quality standards. However, the EIS indicates that the:

"....inventory can provide an indication of the impact development will have on overall air quality."

The aircraft characteristics which were used to define the quantity of pollutants from aircraft activity for the emissions inventory were:

- Aircraft activity levels, fleet mix and engine types.
- Time in operations mode for taxi/idle/delay; takeoff; climbout; and approach.
- Emission factors from the EPA technical reports based upon engine classification and operational modes.

The EDMS computer model is an accepted tool for determining an aircraft emissions inventory. In addition, the aircraft characteristics or data which was used was appropriate and adequate.

The aircraft activity level for the air pollutant emissions inventory was based on a peak hour of about 88 operations (43.9 arrivals and 43.9 departures). The relationship between this activity level and a 60 airplane arrival level per hour recently mentioned by the Port of Seattle (26 March 1996; 1 August 1996) should be discussed in relation to the modeling.

Area Dispersion Analysis

The EDMS computer model evaluates the design and operation of an airport by modeling aircraft emissions during the different operational modes. This includes takeoff, climbout, approach and taxi/idle/delay. Emissions are calculated for up to an altitude of 3,500 feet since emissions above this altitude are not considered to have discernible impacts on ground level air quality.

Vehicle emission rates also are part of the EDMS model which includes MOBILE5A, an EPA mobile source emission program. The emission rates are used to predict air pollutant dispersion from vehicle sources on Airport area roadways and parking lots.

Initially, a screening dispersion analysis was done to determine where there might be potential ambient air quality standard (AAQS) exceedances. This analysis presents worst case conditions in terms of meteorological conditions and Airport operations. The meteorological conditions include: wind direction and speed; temperature; mixing height; and stability class or factor that determines the amount of pollution dispersion (i.e., low to high stability).

The screening analysis involved having a receptor grid in the Airport area for which emission levels were calculated. This receptor grid was confined to approximately 4,900 feet to the east and west of Airport property and approximately 3,000 feet north and south of Airport property not including the land owned by the Airport extending to the north and south of the existing runways.

The receptor grid consisted of 400 receptor locations in a rectangular area around the Airport. Based on this grid, pollutant contours for nitrogen dioxide (NO_2) and carbon monoxide (CO) were developed to determine the locations where the highest concentrations might be found.

NO_2 and CO were selected because according to the EIS they are the two primary parameters of concern around the Airport. However, the screening analysis also included particulate matter (PM_{10}) and sulfur dioxide (SO_2). For the receptor locations which showed a potential problem and receptor locations recommended by EPA, a refined dispersion analysis was done. The dispersion analysis involved the receptor locations for the draft (D) and final (F) EIS shown in Table 2.06.

Table 2.06
Refined Dispersion Analysis Receptor Locations

Receptors[a]	Location
4 (D)	Riverton Heights, SeaTac
4A (F)	Highline Nurseries
5D	Highline, Burien
5A (F)	SeaTac Reservoir
9 (D)	SW SeaTac
9A (F)	Sea-Tac Industrial Park
10 (D)	SeaTac Trailer Park
10A (F)	Des Moines Creek Park
1 (F)	Terminal South
13 (F)	Terminal Hotel
-(F)	Proposed North Unit Terminal
EPA Receptors	**Location**
A (F)	South 154th Street (existing and future)
B (F)	South 188th street on either side of Runway 34R Tunnel (east and west)

(a - Receptor locations are designated by D for Draft EIS and F for Final EIS.)

The purpose of the refined dispersion analysis was to provide a more detailed analysis of the receptor locations which indicated possible exceedances of the AAQS during the screening analysis. The screening analysis indicated that concentrations of NO_2 and CO were of concern and concentrations of PM_{10} and SO_2 were not. Therefore, no further analysis was performed for PM_{10} and SO_2.

This methodology of initially conducting a screening analysis to determine potential areas which exceed AAQS and then conducting a refined analysis of these areas, is an accepted and approved methodology. The data which was used in the modeling appears to be reasonable and the best data available. Also, the Final EIS incorporated changes in the air quality dispersion analysis recommended by EPA, PSAPCA and other groups.

With respect to the receptor locations, it is typical to select locations which are shown to potentially violate AAQS. However, it would have been interesting to have included more receptors in more areas which have experienced air quality complaints (i.e., residential areas) and additional areas with different terrain features in the Airport vicinity. The predicted emissions levels would be useful, even though the screening analysis did not show violations of AAQS.

As discussed below, analyses were also conducted for Airport roadway intersections and construction vehicles. However, it was not clear if the area dispersion analysis also included construction vehicles and aircraft operations together. This should be clarified. Comments from the public indicated that the EDMS area dispersion analysis did not include construction vehicles. Also, the construction haul truck analysis evidently did not include the intersections and EDMS data.

Airport Roadway Intersection Dispersion Analysis

Motor vehicles are believed to be a major source of air pollutants in the Airport area. Thus, a separate more detailed analysis was conducted for the following congested roadway intersections along International Boulevard:

- At South 160th Street.
- At South 170th Street.
- At South 188th Street.
- At South 200th Street.

In addition, the new employee parking area on 24th Street north of SR 518 was included.

EPA's approved model CAL3QHC was used to predict CO levels from motor vehicles. The model requires the following data:

- Traffic volumes for left and right turns and through traffic.
- Level of service determinations.
- Signal cycle lengths.
- Number of traffic lanes available.
- Vehicle speed.
- Vehicle emission rates.
- Meteorological conditions (temperature, wind speed, mixing height, and stability class).

Vehicle emission rates/factors were obtained from the EPA mobile source emission program MOBILE5A. CO levels were evaluated because it is the pollutant emitted in the greatest quantity by motor vehicles and for which short-term health standards exist. Pollutant concentrations were calculated for locations at 12 feet from the edge of a roadway in accordance with the EPA "Guidelines For Modeling Carbon Monoxide From Roadway Intersections." A total of thirty-two receptor locations were modeled in the vicinity of each intersection.

Like the area air quality dispersion analysis, the roadway intersection dispersion analysis in the Final EIS used acceptable methodology. This included incorporating comments on the Draft EIS in the Final EIS, from regulatory agencies, citizens and community organizations.

Human Health - Air Toxics Evaluation

Appendix D and Chapter IV, Section 7 of the Final EIS deals with air quality human health issues. The methodology involved:

- Using the results of the emissions inventory and dispersion modeling.
- Using data from the Port of Seattle's air toxic monitoring program; benzene and thirty-eight additional air toxics were monitored at thirteen on- and off-airport locations for four days during October through December 1993.
- Using information in the April 1993 EPA publication, "Estimation and Evaluation of Cancer Risks Attributed to Air Pollution in Southwest Chicago", which deals with the Chicago Midway Airport area.
- Comparing the toxic emissions information with the DOE's Acceptable Source Impact Levels (ASILs).
- An evaluation of residue samples for evidence of jet fuel related products.

This methodology was acceptable based upon the limited available information on potential air toxics health impacts. The methodology could have been improved as follows:

- The EIS indicates in Chapter IV, Section 7 Human Health: "As the air toxics monitoring program was a preliminary, short-term survey of air toxics over a four day period, it is difficult to assign meaningful significance to short-term measurements as compared to longer-term guidelines. Therefore, as the monitored data was for a limited, short-term period, it is not certain if the actual levels would be exceeded on an annual basis."

  Based on this statement, it would seem reasonable to collect additional, long-term air toxics data throughout different months of the year. Also, limited monitoring sites were off-airport and additional sites should be monitored in particular to the west of the Airport.

Recently a draft Memorandum of Understanding (MOA) was finalized between PSAPCA, EPA, DOE and the Port of Seattle establishing an air monitoring program which may include air toxics depending on the results of airplane engine exhaust residue sampling under flight paths (Puget Sound Air Pollution Control Agency, 24 October 1996).

- The DOE ASILs are established for known or probable carcinogens and other health risks. Thus, the EIS should have contained at least qualitative information on other health risks besides cancer. Based on discussions with citizens and community groups, some health problems appear to be more common in areas near the Airport such as asthma. This should be addressed in more detail.

- The EIS indicates that insufficient information was available to adequately conduct a meaningful cancer risk assessment for human health-air toxics. Data should be collected in order to allow this risk assessment to be conducted.

- The methodology should include an evaluation of potential health impacts on schools, hospitals, nursing homes, and other sensitive areas near the Airport.

- There have been reports or comments from the public concerning fuel odors being worse during periods of inclement weather. These reports need to be verified and evaluated further as part of the air toxics issues studies.

- During discussions with various groups as part of this environmental issues task, there has been repeated comments about vapor recovery at the Airport. This issue should be addressed further since it is unclear what vapor recovery operations there actually are at the Airport. Currently the following vapor recovery operations appear to be in place:

  - The main jet fuel storage tanks have vapor recovery.

  - Individual airlines have vapor recovery on their ground vehicle gasoline fueling operations if they meet PSAPCA throughput requirements.

  - There are PSAPCA regulatory requirements for floating roof tanks.

  - All of the car rental companies located within the Sea-Tac International Airport parking garage are registered with PSAPCA and their underground storage tanks have Stage 1 and 2 Vapor Recovery System equipment.

Construction Vehicles Air Quality Analysis

The construction vehicle air quality analysis also involved a dispersion analysis using the CAL3QHC model and vehicle emission rates from two EPA models: MOBILE5A and Part 5. The overall methodology used was the same as that used for the roadway intersection analysis.

The methodology for the construction vehicle air quality analysis was appropriate for the construction haul routes shown in the EIS. This involved nine haul routes:

- SR 509 - 160th Street on SR 509.
- SR 509 - Des Moines on 160th Street.
- 8th Avenue - 148th Street on Des Moines.
- 8th Avenue - 160th Street on Des Moines.
- 24th Avenue - 16th Avenue on 154th Street.
- 152nd Street to 154th Street on 24th Avenue.
- 200th Street - 188th Street on Des Moines
- 26th Avenue - Des Moines on 200th Street.
- On-airport unpaved haul routes on south side of airport.

However, it appears that the evaluation is based on the assumption that each of these haul routes may be used. Once the sources of fill material are known and the haul routes approved, the construction vehicle air quality analysis should be re-evaluated and dispersion analysis re-done in order to better predict potential air quality impacts.

Air Quality Analyses Results

- **Airport Emissions Inventory** - Airport related emissions are generated by a number of sources including the primary sources: motor vehicles on roadways and in parking lots, and aircraft. The largest source is believed to be vehicles on roadways. For the 1994 condition or base year, the emissions of CO, VOCs and NOx are below the SIP 1990 emissions inventory. The future emissions inventory also indicates that for each EIS alternative and time period, aircraft emissions will be below SIP levels.

  Based on the information presented in the EIS for the EDMS computer model, the existing and future emissions inventory appeared reasonable. Support for the existing conditions air quality was provided by a discussion of DOE/PSAPCA, Port of Seattle and Department of Labor and Industries monitoring programs. However, these are the following issues with these programs and in relation to overall Airport operations:

  - The closest DOE or PSAPCA permanent monitoring sites are approximately 5 miles from the Airport; there are no permanent monitoring sites west, northwest and southwest of the Airport; CO, PM_{10}, are the most frequently monitored parameters at the DOE or PSAPCA permanent monitoring sites.

- The Port of Seattle monitoring was only for compliance with Washington Industrial and Safety Health Act (WISHA) standards and primarily involved indoor air quality monitoring for CO and NO_2; there has been additional monitoring for CO in the main parking garage and the terminal area during late November 1991; it should be noted that the WISHA standards are set for employee, short-term exposure and do not readily apply to areas of public access such as baggage claim and curb front areas; the minimum detection limit for WISHA standards are higher than AAQS and thus are not meant to protect public health.

- The Department of Labor and Industries conducted limited screening for CO for WISHA compliance in seven on-Airport locations and eight off-airport locations during December 1992.

- PSAPCA collected only three samples of black residue for analysis in January 1995 in response to several public complaints.

In order to make monitoring information such as this more useful; permanent monitoring stations should be established in and around the Airport area for select pollutants. Parameters monitored should include the AAQS parameters as well as toxic pollutants of concern such as 1,3 - butadiene, formaldehyde and benzene. Additional comments are made on this monitoring in Section 7. The expanded monitoring to generate baseline data is supported by EPA, DOE and PSAPCA and is addressed by the MOA between these agencies discussed below. The previously mentioned MOA between PSAPCA, EPA, DOE and the Port of Seattle discusses an air monitoring program to be conducted over a 24 month period, commencing the winter 1997. The program that has been funded will focus on the following monitoring activities with the indicated schedule:

- 1996/1997 and 1997/1998 winter seasons: monitoring of CO at roadway intersections modeled in the EIS as creating future exceedances of the CO AAQS and elsewhere in the Airport area.

- Summer/Fall 1997: NO_x emissions monitoring associated with aircraft departure backup queues.

- Schedule to be determined for aircraft fuel particle or residue monitoring.

Depending on the results of the residue monitoring, additional monitoring for air toxics may be conducted. As part of implementing the MOA, public involvement will be solicited via participation in a working group.

It should be noted that funding and a schedule for conducting future fugitive dust measurements at Master Plan Update construction sites and near fill dirt haul routes are not identified in the MOA.

- **Area Dispersion Analysis** - The area dispersion analysis focused on a wider range of sources of air emissions than the air pollutant inventory, which focused solely on aircraft emissions. This dispersion analysis provided information on aircraft and support equipment; on- and off-airport parking lots; roadways; fuel systems; terminal heating and cooling; and aircraft maintenance activities.

  The area dispersion analysis for the existing conditions showed the following:

  - The highest concentrations of CO occur along the terminal curb front; there are no exceedances of 1- and 8-hour CO standards.

  - An exceedance of the NO_2 AAQS was identified at one receptor location on South 154th Street approximately 650 feet north of Runway 162; this receptor is in an area surrounded by Airport property and probably reflected pollutant concentrations from aircraft takeoffs.

  - The screening analysis indicated that concentrations of PM_{10} and SO_2 at all receptor locations were below AAQS; however, as discussed previously, public comments indicated that the EDMS data base may not have included information on particulate emissions and impacts from these emissions may be underestimated.

  The results of the area dispersion analysis for the future conditions indicated the following:

  - With implementation of the Master Plan Update some receptor locations may experience a slight increase in pollutant concentrations; these concentrations would be expected to be below AAQS.

  - The highest NO_2 concentration would occur along South 154th Street; the maximum concentrations would be less than if the Third Runway is not built.

  - The proposed improvements include extension of Runway 16L/34R and NO_2 concentrations would be expected to increase slightly along South 188th Street by the Year 2020.

  - Alternative 3 would result in changes in traffic volumes and movements; therefore, the highest CO concentrations would occur in the terminal area; CO concentrations would be expected to be below AAQS.

  This information presented in the EIS for the area dispersion analysis for both the existing and future conditions will provide a good baseline to evaluate impacts as the Master Plan Update is implemented, However, in order to do this the dispersion analysis will have to be periodically updated with data as it becomes available. Also, public comments indicated the following:

  - The dispersion analysis underestimated the potential impacts of capacity enhancement.

- When reviewing the Draft EIS, EPA requested that the Final EIS increase peak takeoff figures by 20%; however, this evidently was not done.

- During the modeling, arbitrary adjustments were made to the fleet mix and mode which in combination with the above resulted in at least underestimates of NO_2 emissions.

These comments need to be addressed with respect to the original modeling and any future modeling.

- **Airport Vicinity Roadway Intersection Dispersion Analysis** - The Airport vicinity roadway intersection dispersion analysis identified CO concentrations for specific intersections for existing and future conditions. The purpose of the analysis was to evaluate the potential impacts on air quality given traffic volumes and patterns over time. For existing conditions all locations modeled are below the 1-hour CO standard of 35 ppm; however, these locations are modeled to exceed the 8-hour CO standard of 9 ppm with concentrations of approximately 10 to 18 ppm.

  Future conditions were evaluated for the Years 2000, 2010 and 2020. Like the existing conditions, CO concentrations were modeled to be below the 1-hour standard, but to exceed the 8-hour standard. The only exception would be the relocated employee parking area on 24th Street which would be below both standards. This parking area is scheduled to be in use in the Year 2000.

  EPA's technical review of the roadway intersection dispersion analysis raised some concerns about methodological inconsistencies (EPA, 6 June 1996). The EPA indicated the following:

  "The modeling results for air quality in the Sea-Tac Final EIS conflict with those from the Draft EIS for the SR 509/South Access Road Corridor Project at two intersections (both EISs used the same models). The two EISs model conflicting results for existing conditions and future action alternatives at South 188th and International Boulevard, and South 200th and International Boulevard for the average CO concentrations indicated on page 4-7 in the SR 509 EIS, as compared with the same analyses on page IV.9-11H in the Sea-Tac Final EIS. Both analyses model CO violations for existing conditions, but for future action alternatives the Sea-Tac analysis shows modeled CO violations where the SR 509 analysis does not."

  "Modeled air quality impacts at South 200th and International Boulevard are shown in the South Aviation Support Area Final EIS (pages 4-106 to 109 and 112), the 28/24th Street Arterial Final EIS (page 3.22) and the CTI Final EIS (page 4-7, 8). The results vary for each project ranging from 5.0 to 13.3 parts per million CO."

  Based on these comments, the roadway intersection dispersion analysis should be re-evaluated at least for the EPA indicated intersections/roads.

- **Human Health - Air Toxics Evaluation** - As indicated previously, the human health - air toxics evaluation focused on potential changes in toxic emissions from Airport Master Plan Update implementation by conducting an air toxics emissions inventory and comparing the results with the Washington State Acceptable Source Impact Levels (ASILs). The results of the emissions inventory and dispersion modeling indicated the following with respect to volatile gases (TOG), benzene, 1,3-butadiene and formaldehyde:

  - There was insufficient information to conduct a meaningful risk assessment, as previously indicated.

  - The maximum air toxics concentrations at all modeled receptors (i.e., terminal/south, terminal/hotel, SeaTac Reservoir, Highline Nurseries, SeaTac Industrial Park and Des Moines Creek Park) exceeded the annual ASILs; the majority of emissions at each receptor are produced by motor vehicles which contribute about 70% of the toxic emissions, aircraft contribute about 20% (public comments indicated that these percentages need to be better documented since historical data does not support these results).

  - In the future, emissions from roadway sources are predicated to continue to contribute the majority of air toxic emissions; by the Year 2020, motor vehicles are expected to contribute 65% of the toxic emissions and aircraft approximately 25%.

  - Airport activity including heating plants, fuel facilities and surface coating activities, produce low levels of air toxic emissions.

  - By the Year 2000, air toxic emissions are expected to initially decrease as older aircraft are phased-out.

  - Implementation of Alternative 3 would generally result in similar or less air toxic emissions in comparison to the "Do-Nothing" alternative.

The results of the Port of Seattle's 4-day air toxic monitoring program in 1993 indicated the following based on Table 14 in Appendix D of the EIS:

- The mean concentration of the following compounds exceeded the annual DOE Acceptable Source Impact Levels (ASILs): acetaldehyde, benzene; carbon tetrachloride; 1,2-dichloroethane; and dichloromethane.

- Compounds detected which do not have annual or 24-hour ASILs were: CIS-1,2 - dichloroethylene; 1,3,5 - trimethylbenzene; and 1,2,4 - trimethylbenzene.

- Highest concentrations for benzene were along International Boulevard.

- Monitored concentrations for benzene were well below values predicted by a 1991 DOE Study.

- No significant differences in upwind versus downwind concentrations were observed.

- Levels of air toxics were within a range exhibited in other similarly sized urban areas such as St. Louis, Houston and Boston.

- The monitored air toxic pollutant profiles were indicative of automobile exhaust and not due to aircraft exhaust.

The Final EIS also indicated that formaldehyde was above the annual ASIL and acrolein was above the 24-hour ASIL. However, these compounds were not listed in the aforementioned Table 14.

The 1993 monitoring also sampled for CO and found that levels were below the 8-hour AAQS. Because of the limited sampling period, small number of samples, and relatively few sampling stations and their locations, the data is of limited use. It certainly should not be used as a baseline, but should be used as part of a long-term monitoring program.

In January 1994, in response to area resident's concerns, PSAPCA collected and analyzed three samples of residue (black speckles) for analysis. The results indicated that the residues were not similar to unburned jet aircraft fuel and consisted of fungal materials with associated green algae and minerals.

As a follow-up to this sampling, the Port of Seattle conducted another study of the black residues at three separate residences in January 1995. AM Test Labs analyzed these samples as well as a residue sample from the exhaust outlet of a jet aircraft for polynuclear aromatic (PNAs) hydrocarbons and heavy metals. In addition, a microscopic examination was conducted.

The results of this residue sampling indicated that the residue consisted of a variety of substances including fungus, insect particles, minerals/soil and soot. The soot was identified as more typical of motor vehicles or wood burning. Overall the results indicated that the residues are not due to jet fuel-related products. However, comments from the public questioned these results for the following main reasons:

- The quality control procedures followed during sampling were not fully explained.

- The use of the 100 cm swab to collect samples was not related to an overall unit of measurement for surfaces sampled and residue components.

- The soot was not analyzed for specific constituents and therefore the comment in the EIS that residues were not due to jet fuel-related products could not be supported.

As indicated previously, the air toxic analysis primarily discussed cancer effects. The results were not related to other potential health problems such as heart and respiratory disease, which also may be linked to other pollutants such as CO and PM_{10}. This should be discussed in more detail for both existing and future conditions.

Evidence of some of these other health impacts was discussed in, "A Survey and Critique of Epidemiologic Evidence of Adverse Health Effects Attributable Airport-Related Exposure" (Levy, 15 September 1995).

- **Construction Vehicle Air Quality Analysis** - The results of the construction vehicle air quality analysis is presented primarily in Chapter IV, Section 23 and Appendix D. The analysis focused on CO and PM_{10} concentrations and concluded:

  - The maximum CO concentrations along each of the haul routes is expected to be below the CO AAQS.

  - The Alternative 3 concentrations of CO will be equal to or slightly higher that the "Do-Nothing" condition.

  - Without mitigation the PM_{10} concentrations along the haul routes discussed in the EIS are modeled to exceed both the 24-hour and annual AAQS.

  - The Alternative 3-PM_{10} concentrations would be considerably greater than the "Do-Nothing" concentrations.

  The construction vehicle air quality analysis was based on particulate information from a more arid area than the Puget Sound Region, due to the lack of region-specific particulate data. Thus, the PM_{10} results are probably worst case. The lack of particulate data for the Region points out the need to monitor for this information as part of a long-term monitoring effort in the Airport area and Region.

  The CO and PM_{10} construction impact information in the EIS is adequate for the haul routes studied in the immediate vicinity of the Airport. As the Master Plan Update is implemented, source fill areas and haul routes are identified, the construction air quality impacts should be re-evaluated. This evaluation should extend further than the immediate area around the Airport.

- **Clean Air Act Conformity** - Chapter IV Section 9 of the EIS includes a discussion on the need for the Master Plan Update implementation to show that the project will not:

  - Cause or contribute to any new violations of any of the AAQS in the project or metropolitan area.

  - Increase the frequency or severity of any existing violations of AAQS.

  - Delay timely attainment of the AAQS or any required emission reduction in the project area.

  In the EIS, a brief conformity analysis was presented. According to the EPA (6 June 1996), the conformity analysis is only considered a draft and the final analysis should include the following:

"1. Creation of an emissions inventory that includes: (a) all reasonably foreseeable direct and indirect emissions for the pollutants of concern for the year of peak construction emissions prior to 2000 and 2020 [Because conformity requirements for "worse case analysis" differ from NEPA requirements, analysis of emissions during the year of highest impact is required."]; (b) emissions from sources such as construction and haul vehicles, associated increased congestion; and (c) mobile emissions associated with the use of regular gasoline."

"2. An air quality analysis that compares the "no project" and "with project" air quality impacts for the years stated in item one above."

"3. Appropriate mitigation measures - if the "with project" scenario results in an increase in either the frequency or severity of exceedances above the levels in the "no project" scenario, measures should be developed to mitigate these impacts."

"4. Commitments from appropriate governmental entities to conduct adequate, specific and enforceable mitigation measures that will prevent any increase in the severity or frequency of predicted exceedances of the National Ambient Air Quality Standards (NAAQS). Since the increased modeled exceedances occur at intersections outside of airport property, it may be necessary to obtain commitments to conduct these mitigation measures from other agencies or local authorities."

PSAPCA (6 June 1996) also commented on the Final EIS conformity determination for CO. They indicated that the Port of Seattle should ".... make more certain commitments regarding post-2010 project components before conformity to the SIP can be demonstrated." The PSAPCA then offered two options for SIP conformity as follows:

"1. One option would be for the Port to exclude post-2010 project elements from the conformity determination being made now and to make a clear commitment that post-2010 project elements modeled to create future air quality exceedances would not be pursued until additional field monitoring is conducted by other independent environmental agencies. The following would be recommended elements of such an approach:

- *Commit to revisit in future, via a full SEPA/NEPA environmental analysis, the CO air quality impacts and conformity-related mitigation needs of those master plan phases identified as causing post-2010 CO intersection exceedances, e.g., the North Passenger Terminal phase.*

- *Develop a protocol to govern the conduct of future Port-funded CO monitoring activities consistent with the normal monitoring protocols used by state, local and federal air quality agencies and agreed to by those agencies (Ecology, PSAPCA and EPA).*

- *Specify the schedule and technical approach to be relied upon for evaluating modeled vs. monitored data in the future in order to refine exceedance mitigation measures, coordinating with other state, local and federal air quality agencies as necessary.*

- *Institute a memorandum of agreement (MOA) signed by the Port, PSAPCA, Ecology and EPA laying out a funded program for monitoring CO air quality in the Sea-Tac Airport Master Plan project area, and interpreting the results for purposes of implementing conformity-related mitigation measures, ensuring future NEPA compliance and determining future CO monitoring needs. A specific Port commitment to contribute funding should be included in such an MOA."*

"2. A second optian would be for the Port to advance their current FEIS as published - and thus a positive conformity finding for all Master Plan elements - but commit now to actions affecting those post-2010 project phases for which CO air quality exceedances have been modeled, as follows:

- *Specify and commit to implementing a menu of intersection exceedance mitigation measures appropriate to the identified (modeled) CO air quality problems.*

- *Regardless of project phasing, demonstrate quantitatively that the identified modeled air quality problems can be resolved by reliance on all or part of this mitigation menu.*

- *Commit to revisit in future, via a full SEPA/NEPA environmental analysis, the CO air quality impacts and conformity-related mitigation needs of those master plan phases identified as causing post-2010 intersection exceedances, e.g., North Passenger Terminal phase.*

- *Develop a protocol to govern the conduct of future Port-funded CO monitoring activities consistent with the normal monitoring protocols used by state, local and federal air quality agencies and agreed to by those agencies (Ecology; PSAPCA and EPA).*

- *Specify the schedule and technical approach to be relied upon for evaluating modeled vs. monitored data in the future in order to refine exceedance mitigation measures, coordinating with other State, local and Federal air quality agencies as necessary.*

- *Institute a memorandum of agreement (MOA) signed by the Port, PSAPCA, Ecology and EPA laying out a funded program for monitoring CO air quality in the Sea-Tac Airport Master Plan project area, and interpreting the results for purposes of implementing conformity-related mitigation measures, ensuring future NEPA compliance and determining future CO monitoring needs. A specific Port commitment to contribute funding should be included in such an MOA."*

Based on these comments, it is obvious that the EIS Clean Air Act conformity discussion is incomplete. As the Master Plan Update is implemented, the public should be kept abreast of issues and status of the analysis.

- **Certification of Compliance With Air Quality Standards** - The EIS indicates that the Washington State's Governor's Office must issue a certification indicating that implementation of the Master Plan Update will comply with all applicable AAQS. The Governor's Air Quality Certificate is expected to be issued before completion of the Federal Aviation Administration Record of Decision.

Cumulative Impacts

The EIS did not adequately address air quality cumulative impacts associated with Master Plan Update implementation and other major proposed projects in the area. This also was commented upon by EPA (6 June 1996).

This issue needs to be addressed and would most likely include some revision to several areas of the air quality analysis, in particular, those associated with modeling air emissions and the construction vehicles air quality analysis. The EPA (6 June 1996) specifically indicated that cumulative impacts discussion should include the extension of SR 509; South Aviation Support Area aircraft maintenance facilities; Des Moines Creek Business Park; SeaTac Hotel; the proposed Cell Therapeutics Inc. (CTI) campus; and the 28th/24th Avenue South arterial project.

The EPA also mentioned the new Federal Detention Center immediately south of the Airport and the improvements to 3 miles of International Boulevard near the Airport. Both of these projects are currently ongoing.

Other projects which the EIS briefly describes in Chapter III Affected Environment are: regional transit authority high capacity, light rail system; and the aviation business center. The CTI campus development is included as part of a larger program, the Des Moines Creek Technology Campus.

The issue of cumulative impacts also was inadequately addressed for noise, water resources, and aesthetics and visual environmental issues. Thus, cumulative impacts need to be seriously evaluated, not just alluded to in a brief discussion.

Mitigation Measures

Mitigation for potential air quality impacts from Master Plan Update implementation are addressed for the following general topics:

- Construction impacts in particular for fugitive dust emissions.
- Mitigation at International Boulevard and South 170th Street and South 160th Street.
- Incentives or other regulatory requirements for reducing emissions.

Construction mitigation measures focus on excavation and wind erosion of soils; vehicle traffic on paved and unpaved roads; and cement and aggregate handling. Potential impacts from construction will be mitigated by implementing a Construction and Earthwork Management Plan which will designate haul routes, dust control techniques, etc.

Mitigation for the International Boulevard intersections of concern in the EIS include primarily construction of additional turn lanes. These improvements would occur by 2010 with other improvements by 2020. Other proposed mitigation measures include the Port of Seattle's support of the seasonal use of oxygenated fuels (which will be ended); wood burning stove curtailment initiative; and the vehicle inspection/ maintenance program.

The EIS also briefly discusses ongoing Airport activities to reduce emissions and additional actions which could further reduce air emissions.

These ongoing and proposed mitigation measures will be discussed in more detail in the Mitigation Plan. The EIS proposed mitigation measures are generally appropriate. Additional measures and issues which need to be addressed in the Construction and Earthwork Management Plan are discussed further in Section 7.

2.07 - WATER RESOURCES

In the EIS water resource issues are evaluated in terms of water quality and hydrology; wetlands; and floodplains. These areas include the Task 5 Environmental Analysis Scope of Services areas of concern which are: floodplains; storm drainage and surface runoff; and wetlands. These areas are incorporated in the discussion which follows.

Water Quality and Hydrology

Water quality and hydrology issues in the EIS are discussed in Chapter IV, Sections 10 and 23, Chapter V, Appendices F, G, P, Q-A, Q-B and part of Appendix R. These issues focus on potential impacts on surface water and ground water resulting from construction and operation of the proposed Master Plan Update implementation.

- **Methodology** - Surface water and ground water resources were evaluated by reviewing existing information and modeling hydrologic conditions of the Airport, Miller Creek and Des Moines Creek using the HSP-F Version 10 continuous simulation model. Also, average sediment production caused by erosion was estimated using the Revised Universal Soil Loss Equation (RUSLE).

  The baseline data used for the hydrological analysis for both the present and Master Plan Update conditions included the following:

- 47-year records of hourly precipitation from the Sea-Tac International Airport weather stations.

- 5-year flow records at the Miller Creek and Des Moines Creek stream gauging stations.

- Watershed data such as river basin drainage areas, land use status, and area soil types and classifications.

- Limited surface water and ground water quality information.

The key parameters/assumptions used in the HSP-F hydrological modeling analysis appear reasonable and engineering sound. These parameters include the runoff coefficient for different land surfaces, and the permeability and infiltration rates for the various soil formations. As part of the modeling assumptions, it is stated that:

> *"The Industrial Waste System (IWS) has a hydraulic capacity of between the 10- and 25-year storm events and overflows to the SDS during large storm events."*

This implies that the Airport SDS could receive untreated runoff from the IWS and requires a better explanation. However, the Washington DOE indicat that the IWS does not overflow to the SDS. Evidently, the IWS may backup onto the tarmac and cause local flooding. Also, in an extreme event, the third lagoon could overflow to Des Moines Creek, although this has never been known to have happened. The Port of Seattle is currently sealing manhole lids to surcharge the system in order to prevent localized flooding.

The RUSLE is an appropriate method of estimating average sediment production from erosion. The HSP-F model also is an appropriate way to assess the effects of the overall land use changes to derive stormwater detention capacity required to meet offsite discharge limitations. However, since a detailed presentation of proposed stormwater facilities (i.e., catch basins, conveyance pipes, stormwater ponds and pond outlet works, etc.) was not incorporated into the HSP-F model, the effect of these facilities on the determination of detention capacity was excluded. To complete the effort, a separate hydraulic analysis with computer program (WATERWORKS), modeling the proposed airport expansion Storm Drain System (SDS) within the Sea-Tac International Airport is being done. This will determine if the SDS would have a significant impact on the results so far obtained from the HSP-F modeling. At the time of the Final EIS only preliminary WATERWORKS model files were available. Therefore, the results of the stormwater system modeling analysis using WATERWORKS needs to be evaluated.

The baseline data used for the limited water quality and hydrology studies is based on available historical information from various agencies and publications. Thus, it is believed to be reliable and of acceptable quality. With the respect to surface water and ground water quality, there is a paucity of data which is typically included in an EIS. The surface water quality information in Table IV.10-3 only addressed 15 parameters and does not include some routinely monitored parameters such as flow and specific conductance.

For some parameters such as dissolved oxygen and temperature there is limited information. If a baseline is to be established to measure both potential construction and operational changes in surface water quality from the Master Plan Update implementation, additional more detailed surface water quality studies need to be conducted. They should be initiated before construction activities begin; seasonal sampling should be conducted (e.g., February, May, August and November); the parameters sampled should include a number of metals and organics (e.g., aviation fuel constituents, and ethylene and propylene glycol) which are based, in part, on the parameters for which water quality standards have been set; and the parameters should include those for which the Port of Seattle monitors for on the Airport such as in stormwater discharges. A recent study of the latter included information on 23 parameters (Port of Seattle, 30 June 1995).

There is essentially no groundwater quality information in the EIS. This information should be developed for parameters similar to those sampled for in surface water plus static surface water level. Also, a seasonal sampling regime should be developed.

A number of surface water sampling stations should be established on Miller Creek, Walker Creek and Des Moines Creek, starting at the headwaters. Ground water sampling stations also should be established in the various aquifers. These stations should take advantage of existing water supply wells including those of the Seattle Water Department and the Highline Water District.

Currently, the Port of Seattle is conducting a Receiving Water Monitoring Study which will contain updated water quality information for Miller Creek and Des Moines Creek. This study is due to be submitted to the Washington DOE on 30 June 1997. The study should be reviewed to ensure that adequate water quality information is provided.

When determining the extent of the groundwater monitoring program, the numerous cleanup studies which have been conducted at Sea-Tac International Airport should be considered. These studies include information on the hydrological conditions at the Airport and groundwater data from the Airport monitoring wells. With respect to monitoring wells, the Washington DOE has indicated that wells should not be drilled into deep drinking water aquifers in areas with known and unknown shallow soil and perched groundwater contamination at the near surface (in particular free product). This is because surficial contamination might spread through the monitoring wells to these aquifers.

According to the South King County Water Advisory Committee, et.al. (April 1991), long-term water level declines of 1 foot/year have been observed in the Des Moines Area. It was speculated that the water level declines may be due to urbanization and associated reductions in recharge. Thus, it was recommended that a comprehensive monitoring program including well water levels and pumpage, stream flows, lake levels and water quality should be implemented. It also was indicated that particular emphasis should be placed on hydrologic monitoring of aquifers in the Des Moines and Federal Way areas.

The South King County Water Advisory Committee, et.al. (April 1991) also made the following observations:

- The Seattle Water District's monitoring well network and the stream gauging on Miller Creek should be adequate for monitoring ground water in this area of the Des Moines Upland.

- Activities along Miller Creek need to be closely monitored and evaluated because of its sensitive recharge characteristics.

- In the Federal Way Upland, surface water monitoring sites should be maintained in order to ascertain impacts to the surface water system.

- Groundwater quality monitoring along International Boulevard should be closely evaluated to ensure that contamination from various activities is not occurring.

- The Sea-Tac International Airport area because of its significant industrial and commercial activities with numerous underground storage tank and fueling operations is a sensitive area and should be closely monitored.

• **Existing Conditions** - The hydrology analysis includes baseline information on the following for Miller Creek and Des Moines Creek Watersheds (Basins):

- Flood frequencies.
- Average seasonal flow rates.
- Annual runoff volumes.

The descriptions of the existing hydrology conditions for Miller Creek Watershed are deemed adequate and form a good baseline from which to monitor future conditions. The information on the approximate 75% of the Des Moines Creek Watershed which was modeled are also adequate. However, consideration should be given to modeling the entire Des Moines Creek Watershed, not just from the headwaters to South 208th Street. It is not completely clear why all of this watershed was not modeled. The hydrology description of the Miller Creek and Des Moines Creek Watersheds was based on the following information (Table 2.07).

Table 2.07
Watershed Hydrology

Watershed	Total Area	Total Impervious Area	Airport Impervious Area
Miller Creek	5,183 acres	1,224 acres	60 acres
Des Moines Creek	3,585 acres	1,202 acres	369 acres

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

The primary land uses in the watersheds are residential and commercial with only 4% and 27% of the land devoted to Airport use in the Miller Creek and Des Moines Creek Watersheds, respectively. Thus, the urbanized watersheds exhibit stream flow characteristics associated with developed watersheds or basins. This includes rapid flow rate increases before and decreases after precipitation events.

Creek flow rates are typically highest from October through April and lowest between May and September. The existing flood frequencies are described as follows based on three and two locations along Miller Creek and Des Moines Creek, respectively:

Table 2.08
Flood Frequencies

	Existing Condition Return Period (Years) / Flow Rate (cfs)			
Watershed	**1.11**	**2**	**10**	**100**
Miller Creek	47-104	80-173	125-293	171-468
Des Moines Creek	74-76	103-112	154-178	232-280

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

As one would expect the higher flow rates are experienced at downcreek locations. The probability of the flow rate return periods are: 1.11 year, 90%; 2 year, 50%; 10 year, 10% and 100 year, 1%.

Miller Creek and Des Moines Creek and their tributaries are classified as Class AA (extraordinary) waters by the Washington DOE. Although the creeks occasionally violate the Class AA water quality standards for pH, dissolved oxygen and ammonia. These violations are due primarily to pollutants found in urban and Airport stormwater runoff such as nutrients; oil and grease; metals; fecal coliforms; and suspended solids.

Information on estimated pollutant loadings from the Airport and other sources for each watershed are presented for total suspended solids; biochemical oxygen demand; total phosphorus, copper, lead and zinc; and oil and grease. Overall water quality for select sampling locations along Miller Creek and Des Moines Creek are presented for only fifteen parameters.

Four zones of ground water are described in the EIS with the following general characteristics:

- *Perched Zone* - No known use for drinking water; quality unknown, assumed to be good. The Washington DOE has indicated that there is a 30 to 50-foot blanket of glacial till at the Airport which contains numerous perched zones of groundwater. The perched zones are small, discontinuous, have various flow directions, and are often seasonal. Perched groundwater is the most contaminated at Sea-Tac International Airport and in many instances perched groundwater has trapped contamination and prevented it from reaching the deeper QVA aquifer.

- *Upper or Shallow Aquifer (QVA, Vashon Advance Outwash)* - Not used for domestic water supply; localized contamination from leaking jet fuel and rental car fuel distribution systems at the Airport.

- *Intermediate or Highline Aquifer (Qc(3), Third Coarse Grained Deposit)* - Seattle Water Department has three operating potable water supply wells and Highline Water District has two wells; 80 to 200 feet beneath the ground surface; no indication of ground water contamination; wellhead protection plans to protect wells from pollution within at least the 10 year time of travel zone or about 1/2 mile radius around each well.

- *Deep Aquifer (Qc(4), Fourth Coarse Grained Deposit)* - Excellent water quality.

As indicated above, there is inadequate surface water and ground water quality information. Before implementation of the proposed Master Plan Update activities, this data should be developed. It should include both available literature information and seasonal sampling data. In addition, there should be a surface water and ground water sampling plan in case there are spills on Airport property that reach the Miller and Des Moines Creek drainages. The information developed from this sampling should be compared with applicable standards and remedial actions taken, if necessary. The ground water information is particularly important to help determine potential future impacts on aquifers. It should be noted that since June 1995, the Port of Seattle had a *Spill Prevention, Control and Countermeasure (SPCC) Plan* which included a sampling plan in case of spills. The SPCC Plan should be reviewed and any additional surface and groundwater sampling should be consistent and coordinated with the SPCC Plan.

The EIS indicates that the Highline Aquifer is protected from existing contamination by overlying aquitards and various hydrologic characteristics. However, there is evidence that when wells are pumping water from this aquifer, drawdown can be observed in shallower aquifers (Greg Wingard, 22 July 1996, personal communication; Wingard and Smith, 19 June 1995). This is indicative of interconnection between the aquifers and a potential path for contaminated ground water to the Highline Aquifer. Therefore, ground water movement in the Airport area needs to be better defined. According to the EIS, these additional studies are being conducted and the Washington DOE has indicated that modeling will assume that there is a connection between the upper and lower aquifers. When available, the studies should be reviewed for potential ground water contamination impacts on the Highline Aquifer and other area aquifers.

Parts of the existing Airport's aircraft fuel handling system are known to have leaks and to have contaminated ground water. This is due, in part, to an aging fuel handling system, in particular the Northwest Airline's facilities. The Port of Seattle has recognized the need to upgrade and modernize the Airport's fuel handling facilities. This aspect of Airport operations should be done as part of Master Plan Update implementation.

In the EIS it is indicated that the Port of Seattle was to have conducted a monitoring study of Miller and Des Moines Creeks the winter of 1995 to 1996, both upstream and downstream of Airport stormwater discharges. The purpose of this study is to help determine the toxicity of Airport stormwater runoff and surface water quality. The results of this study need to be evaluated.

- **Future Conditions** - It is estimated that implementation of EIS preferred Alternative 3 would result in the following:

  - *Miller Creek* - 97 acres (new impervious surface area), 264 acres (drainage from fill area).
  - *Des Moines Creek* - 95 acres (new impervious surface area), 282 acres (drainage from fill area).

This is approximately 7% to 11% of the total watershed areas based on 5,183 and 3,585 acres in the Miller Creek and Des Moines Creek Watersheds, respectively. The increases in impervious areas are approximately 8% to 24% with existing impervious areas of 1,224 and 1,202 acres in the Miller Creek and Des Moines Creek Watersheds, respectively.

To minimize the potential impacts of the new impervious areas and drainage areas, new stormwater detention facilities are planned. If the preferred alternative is implemented the hydrologic analysis and stormwater management facilities should be re-evaluated to support final design. This is particularly true since the EIS indicates that the stormwater management facilities and discharge locations are conceptual layout. The re-evaluated hydrologic analysis should then be used as part of the baseline to monitor potential Alternative 3 impacts. During large storm events, the effect of possible overflow from the IWS on the receiving waters also should be addressed.

Limited details on both the construction and operation of the wet vaults and biofiltration swales was provided in the EIS. There was a more lengthy explanation of the constructed aquifer, which the EIS indicates has not been used before to manage stormwater. More detailed design and operating information needs to be provided on the wet vaults and biofiltration swales. If additional consideration is given to the constructed aquifer, its potential use must be more strongly justified. The Sea-Tac International Airport area may not be the most suitable place to try this technology out; especially considering the controversy over disturbing the headwaters of the two watersheds. The King County Surface Water Management Division has suggested that surface water retention facilities are more innovative and effective. Therefore, they should be considered further before the use of wet vaults and/or the constructed aquifer. The surface water facilities potentially could include modifying the Lake Reba facility for better water storage capacity and water quality treatment.

The Washington DOE also believes that if a constructed aquifer is proposed, additional analysis should be provided since it might not be appropriate for the Airport site. However, the Washington DOE has indicated that the constructed aquifer has the potential to provide a better mechanism for groundwater recharge to Miller Creek.

Future Miller Creek and Des Moines Creek flow rates were described for the same locations as the existing conditions. They are summarized in Table 2.09.

Table 2.09
Future Flood Frequencies

	Future Condition Return Period (Years) / Flow Rate (cfs)			
Watershed	**1.11**	**2**	**10**	**100**
Miller Creek	46-103	76-170	119-285	166-454
Des Moines Creek	68-74	96-108	149-173	232-280

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

As can be seen from comparing the future condition flow rates with the previously mentioned existing condition flow rates, the flow rates are very similar. However, the EIS indicates that the annual runoff volumes will increase 6% to 11% at various locations in Miller Creek and 1% to 2% in Des Moines Creek. Most of the volume increase (97% to 99% would occur at flow rates less than the 2-year return period flow rate.

Construction impacts on Miller Creek and Des Moines Creek hydrology are really not discussed in the EIS; the emphasis is more on construction water quality issues and post-construction hydrology. If the mitigation procedures discussed in Appendix P, Natural Resource Mitigation Plan, are not adequately coordinated with the embankment fill activities, there could be problems with surface water runoff from precipitation events. The Construction Stormwater Pollution Prevention Plan referenced in the EIS should help control surface runoff quantity and quality. However, the details of this plan need to be developed and evaluated.

Construction impacts on burrow source site ground water hydrology would involve altering geology and changing ground water recharge, movement and discharge patterns. In general, glacial till areas may be removed which will expose more permeable areas. This could result in reductions in perched ground water and increases in upper aquifer recharge depending on the geology at the burrow sites and should be monitored. Construction in the area of the Third Runway would reduce upper aquifer recharge because of the impervious area. However, depending on the locations of the burrow source sites, this loss could be compensated for by the increased recharge at the burrow sites.

Once the Third Runway is in operation, aquifer recharge would be expected through the relocated Miller Creek and Des Moines Creek channels and other stormwater management facilities. Although the amount and success of this recharge cannot be accurately predicted and should be monitored.

There also would be potential surface water and ground water quality changes during both construction and operation. However, potential future impacts deal mainly with total suspended solids (TSS) and spills of materials such as fuels, lubricants and other materials. Based on the more detailed surface water and ground water quality information which should be collected, the future conditions discussion should include more than TSS and spilled materials. Although TSS is probably the most important parameter, in particular during construction and before the fill and burrow areas have adequate vegetation.

In EIS Chapter IV, Section 19 Earth, it is indicated that fill material will be "... placed in layers using common construction techniques." It is assumed that this includes compacting the fill to obtain appropriate densities, which may require large quantities of water. The source of water will have to be identified to ensure that it is from an acceptable source.

In some areas where fill has been placed, there have been reports of ground water levels rising in the fill. This needs to be evaluated with respect to the proposed Airport fill operations, including verification of this observation.

- **Cumulative Impacts** - In the EIS cumulative impacts of Airport Master Plan Update implementation and the relationship to other projects is discussed generically. A more detailed evaluation should be made. Master Plan Update implementation might have water quality and hydrology impacts which can be mitigated to minimize impacts; but, in combination with other projects, could have significant impacts.

- **Mitigation** - Relatively extensive water quality and management facilities are proposed, primarily to control stormwater. The mitigation measures will be expanded upon in the project's stormwater management plans. Overall the mitigation plans presented in the EIS are appropriate. However, additional comments will be provided in the mitigation plan task of the scope of services.

  If the proposed stormwater management facilities are built, they should be closely monitored to ensure that they work according to their design. This should include monitoring operation of the underground vaults such as collecting water samples before and after the vaults.

  As the Natural Resource Mitigation Plan is implemented, the plan also should be evaluated for conformance with the various City Comprehensive Plan and Stormwater and/or Surface Water Management Plans. For example, in the City of Burien's stormwater plan there are comments concerning the following with respect to the headwaters of Miller Creek:

- There is the possibility of building a major stormwater detention system on the Vacca Farm property which encompasses an area in the City of SeaTac of approximately 25 acres.

- If this development were to be operated in conjunction with Lake Laura and Lake Reba, stormwater could be better controlled for this area of Miller Creek.

Also, the Greater Des Moines Comprehensive Plan discusses some issues and mitigation measures associated with streams, ground water, water quality, stormwater and wetlands.

As part of mitigating potential impacts on Miller Creek, the upper reaches will be relocated. In the early 1970's there was litigation concerning development activities in the Miller Creek Basin. Under the settlement agreements, King County agreed that it would "... not in the future attempt the channelization of Miller Creek except in limited amounts in connection with retention facilities." The relationship between this stipulation and the proposed relocation of part of Miller Creek will have to be resolved as construction associated with Master Plan Update implementation proceeds.

2.08 - WETLANDS

The EIS discussion of project area wetlands is included primarily in Chapter IV, Sections 11 and 23, Chapter V and Appendices H-A, H-B, P and part of Appendix R. Raytheon's comments on wetlands follows.

Methodology

The evaluation and identification of wetlands in an area is always a sensitive issue. Wetlands play an important part in an ecosystem and they should be protected.

The wetlands in the area around the Airport were identified by accepted and appropriate methods. This included a review of literature information, discussions with appropriate staffs of various agencies, and ground-truthing. This resulted in wetlands being identified based on the soil and vegetation characteristics, and hydrologic regime.

Although accepted methodologies were used, these methodologies were not related enough to the wetland provisions of King County's Sensitive Areas Ordinance (King County Ordinance 9614, Sections 97 through 105). Thus, the EIS should have included a better discussion on at least the following key provisions of King County's wetland provisions:

- Wetland rating: unique/outstanding; significant; and low concern.

- Buffers/setbacks: establishes buffers by wetland rating; provisions for increasing the buffer width; and minimum building setbacks.

- Mitigation, restoration, enhancement and replacement.

Existing Conditions

Fifty-five individual wetlands, or approximately 144 acres, were identified in the study area. Based on the information available to Raytheon, it appears as if a good job was done at identifying the wetlands. In fact, one person in the State of Washington, Department of Ecology, believes that some wetland areas to the west of the Airport were over delineated. However, the wetland information in the EIS is a good basis for predicting future impacts.

Future Conditions

Of the 55 wetlands, 34 could be impacted by Master Plan Update implementation of Alternative 3 and construction of the 8,500-foot runway. This would result in approximately 10.4 acres of wetlands being destroyed during construction; there would be no additional disturbance of wetlands during operations unless there is some sort of spill at the Airport which reaches the watersheds or the planned mitigation measures for the hydrologic regime do not work. The latter could result in additional wetlands losses, from areas drying-up.

The wetlands which would be destroyed as part of Alternative 3 include 7.07 acres of forested wetlands, 2.88 acres of emergent wetlands, and 0.39 acres of shrub-scrub wetlands. According to the EIS, forested and shrub-scrub wetlands are usually considered to provide greater flood energy dissipation and wildlife nesting habitat than that provided by emergent wetlands: whereas emergent wetlands are generally considered to provide greater water quality improvement functions and wildlife feeding opportunities. The EIS also indicated in Appendix H-A that:

> *"Removal or alteration of wetlands as a result of the proposed project and other projects in the area, may limit the ability of remaining wetlands to perform the lost or diminished functions. This may be particularly true of stormwater storage functions of wetlands in the project vicinity. Increased impervious surfaces associated with development activities at the Airport may increase both the depth and duration of stormwater in remaining wetlands. This could result in increased floodwater elevations for longer periods of time in the watershed."*

Also, it was indicated that most wetlands in the area provide wildlife habitat, although they are fragmented and small, and:

> *"...their overall wildlife habitat function should not be overemphasized."*

Cumulative Impacts

The discussion of cumulative impacts to wetlands of Master Plan Update implementation and other proposed projects, was cursory. Cumulative impacts should be re-evaluated based on the other known proposed projects as listed in Chapter III Affected Environment. Although the projects listed are located primarily to the east and south of the Airport.

Mitigation

The Port of Seattle believes that it is not possible to mitigate in the Miller Creek Watershed for wetlands which will be lost as part of the Master Plan Update implementation. Thus, the wetland mitigation site is proposed for the lower Green River Valley (City of Auburn) in another watershed. It is a Washington State policy to mitigate for wetlands in the impacted watershed, if possible. But, projects are dealt with on a case-by-case basis and if necessary wetlands can be mitigated in another watershed.

The Port of Seattle has investigated over 100 parcels in the Airport area. Despite this effort, there are many citizens and some government personnel who believe that the loss of the wetlands in the Miller Creek Watershed should still be mitigated in this watershed. Thus, the Port of Seattle should have to continue to justify its wetlands mitigation plan and should be open about the process it is going through. This is particularly true with permitting with the US Army Corps of Engineers and discussions with the City of Auburn.

2.09 - FLOODPLAINS

Floodplains were discussed primarily in the EIS in Chapters IV, Section 12 and V, Appendix P and part of Appendix R. An evaluation of these parts of the EIS follows.

Methodology

Proposed Master Plan Update area flooding and 100-year floodplain information was obtained from existing information, in particular the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps. Potential impacts on flooding and floodplains were then determined by evaluating construction impacts and modeling post-construction flows. This methodology is acceptable and routinely used in evaluating at least 100-year floodplains.

The methodology did not include a discussion on the 500-year floodplain, which is relevant because of recent storms. There should be some discussion about the 500-year floodplain since this information is available in literature such as the FEMA maps.

Existing Conditions

Miller Creek has more extensive 100-year floodplains than does Des Moines Creek. Miller Creek essentially has floodplains along its entire length in depressions and relatively flat areas with little topographic relief. Des Moines Creek only has a 100-year floodplain below South 216th Street. These existing floodplains were adequately described in the EIS.

If the Master Plan Update implementation proceeds, the floodplain information should be updated as new data is available. This particularly includes revision of the FEMA maps. This will then allow a better comparison with future impacts.

Future Conditions

As indicated in the EIS, development requirements prohibit significant floodplain encroachment and reduction of flood storage capacity. As discussed in the EIS, without mitigation the proposed Master Plan Update could result in the following:

- Significant floodplain encroachment.
- Reduced flood storage capacity.
- Increased flow rates and volumes.

This could result in flooding in downstream areas adjacent to Miller Creek and Des Moines Creek.

For Alternative 3, the 8,500-foot runway could result in the loss of approximately 7.2 acres of 100-year floodplain in the vicinity of Lake Lora at the headwaters of Miller Creek. This loss of floodplain results in loss of flood storage capacity and possibly increases in flood heights in downstream areas. These impacts would depend on the amount of flood storage lost; stormwater runoff detention facility storage volume and release rates; and the timing of peak release rates with respect to other areas in the watershed or basin.

The amount of new impervious area also will potentially impact the amount of stormwater runoff and resultant flood impacts. The proposed 8,500-foot runway would have approximately 73 acres of impervious area of the approximate 192 acres of total impervious area.

The EIS evaluation of potential future impacts on floodplains was good. It forms a basis to evaluate actual changes as the Master Plan Update is implemented.

Cumulative Impacts

As with the other water resources related cumulative impacts discussions, this aspect of the floodplains evaluation is cursory and inadequate. Proposed new projects should have minimal, if any, potential impacts on the Miller Creek Watershed. However, there could be negative impacts on the Des Moines Creek Watershed floodplains.

Because of these potential impacts in combination with implementation of the Master Plan Update, there should be a more lengthy discussion of cumulative impacts. If enough information is available on these other projects, the evaluation should include incorporation of this information in the hydrology modeling. The resultant data could then be used for the cumulative impacts discussion associated with all water resources.

Mitigation

Floodplain mitigation would include adherence to floodplain development standards and floodway management requirements of the FAA and the Washington DOE. The development standards prohibit any reduction in the 100-year floodplain or base flood storage volume. State law requires compensatory mitigation for any proposed filling of 100-year floodplain so that there is no net loss in flood storage capacity. Also, the mitigation is to prevent an increased risk of loss of human life on property damage.

According to the Washington DOE, the primary mitigation goal is to replace the basic characteristics of Miller Creek and its tributaries. The mitigation objectives require that Miller Creek and its tributaries must continue to provide baseflow conveyance functions, accommodate the 100-year flow with no net 100-year storage loss, and the new tributary must provide an open channel of equivalent length as the existing tributary. This, mitigation must maintain the natural characteristics and functions of Miller Creek.

For the Master Plan Update compensatory mitigation primarily involves the following:

- Relocating approximately 1,080 feet of the main channel of Miller Creek approximately 200 feet west.
- Enhancing the habitat features of the relocated channel.
- Replace three intermittent tributaries of Miller Creek that will be in fill by constructing tributary mitigation channels.
- Relocating part of Des Moines Creek, which depends on development of the South Aviation Support Area.

The Washington DOE observed that the proposed mitigation plan would create 5,070 cubic yards of floodplain storage to offset 5,030 cubic yards of storage that would be lost in the proposed fill area. In addition, consideration is being given to modifying the operating procedures at the Lake Reba Regional Detention facility. This is supported by the King County Surface Water Management Division, in particular if the facility can be modified for additional water storage and water quality treatment.

In order to determine the effectiveness of the creek relocations and tributary replacement, a monitoring plan is proposed. The monitoring includes hydrology and hydraulics inspections and maintenance, and a contingency plan. The latter would involve primarily channel modifications to meet required flow rates and stream hydrology.

The proposed mitigation plan for Miller Creek and Des Moines Creek addresses floodplains, and water quality and hydrology. If implemented correctly, the plan should minimize the potential impacts of Master Plan Update implementation. However, with respect to floodplains, the EIS indicates that:

> *"Implementation of these mitigation requirements would be expected to prevent significant floodplain or flooding impacts from the proposed Master Plan Update alternatives."*

The plan does not guarantee that the mitigation measures will work. Therefore, monitoring of the mitigation measures construction and operation is extremely important.

2.10 - AESTHETICS AND VISUAL

Chapter IV, Section 24 and Appendix N of the Sea-Tac International Airport EIS deals with aesthetics and urban design.

Eighteen view-sites around the Airport's perimeter were used to describe the existing visual character of the Airport and to assess impacts of Master Plan Update implementation. Existing conditions were based on black and white photographs from the different viewpoints; three dimensional representations of the Master Plan Update alternatives were overlain on the photographs to show the expected changes or impacts.

The methodology used is routine for visual impact studies. However, the number of viewpoints was inadequate, in particular to the west of the Airport. Additional viewpoints should be included in the study, in particular on high ground. Two examples are in the City of Burien at 153rd and 4th Streets, and 160th between 9th and 10th Streets.

The use of black and white photographs makes it difficult to see existing and Master plan Update conditions. Color photographs should be used to more clearly show the Airport facilities. In addition, different stages of construction such as site clearing, earthwork and final design with/without landscaping should be shown.

Existing Conditions

The initial black and white photographs were used to show the context in which the Airport is located. However, the majority of view sites are located relatively close to the Airport. There are only a few view sites located further away and these are primarily to the northwest and south of the Airport.

As indicated above, more view sites and color photographs should be used to better describe the existing visual conditions of the Airport. The existing conditions description also should include a discussion of the ground shadow which is cast on the surrounding area from the existing embankment.

Additional view sites to the west, northwest and southwest of the Airport are particularly important because construction of the Third Runway will bring the runway activities approximately 1/2 mile closer to these areas.

The larger fill area also will be closer and will eliminate some of the view sites shown on Exhibit IV.24-1 in the EIS.

The existing condition view sites to the west, northwest and southwest also should more clearly show aircraft on the existing runways and possibly landing and taking-off. The view sites now show primarily trees and the embankment area and it would have been helpful to show airplanes, where possible.

Future Conditions

The treatment of future visual conditions is inadequate because the conditions are mainly described in the immediate area around the Airport. More view sites should be evaluated, in particular on high topographic relief points to the west of the Airport. The ground shadow which will be cast by the new embankment for the Third Runway also should be discussed in more detail than indicating that it will be about 15 minutes longer than the current shade.

Like the existing conditions, aircraft operations on the proposed Third Runway on the ground should be more clearly shown. This would be particularly helpful for the additional view sites to the west, northwest and southwest of the Sea-Tac International Airport.

Construction of the Third Runway will bring aircraft activities on the ground and in the air approximately 1/2 mile closer to the area west of the airport, in particular during landings and takeoffs. Therefore, the impact of aircraft in the air during landings and takeoffs should be shown and discussed in comparison to the existing conditions.

Cumulative Impacts

It is indicated that cumulative visual impacts could vary depending on what other developments are implemented. These potential developments should be described in relation to the proposed Master Plan Update improvements. If the visual impacts of these developments and the Airport improvements are deemed significant, visual representations should be presented.

Mitigation

As part of evaluating additional view sites, consideration needs to be given to developing short-range, medium-range and long-range views. For example, to the west of the Airport the viewpoints might be as follows: short-range, 1/2 mile or less from the Third Runway; medium-range, 1/2 to 1 mile from the Third Runway; and long-range, 1 to 1 1/2 miles or more from the Third Runway. The different viewpoints and their distance from the Third Runway area will depend, in part, on the topography.

Visual impact mitigation alludes to adherence to applicable design and landscape codes. It is assumed that this refers to the City of SeaTac Chapter 15.14 Development Standards: Tree Retention and Landscaping. These standards should be used taking into consideration the use of native vegetation of different age class that will minimize maintenance. Vegetation plantings should be used to minimize visual impacts on the Third Runway's embankment and off-site at sensitive viewpoints such as along 153rd and 4th Streets. Mitigation is discussed in more detail in Section 7.

SECTION 3

EIS TRANSPORTATION ANALYSIS

SECTION 3
EIS TRANSPORTATION ANALYSIS

3.01 - INTRODUCTION

Section 3 provides analysis regarding the traffic and transportation impacts due to construction of the proposed Third Runway at Sea-Tac International Airport. Section 8 addresses the potential traffic and transportation impacts and mitigation of implementation of the full Airport Master Plan.

The EIS forecasts were used in the analysis to assess traffic and transportation impacts and in development of the Mitigation Plan to address those impacts. This approach was taken due to the fundamental decision made early in the study to base the impact analysis on the data presented in the *Final Environmental Impact Statement, Proposed Master Plan Update to the Seattle-Tacoma International Airport.* The EIS contained traffic forecasts and projections for the following years:

- Year 1994 - Base condition
- Year 2000 - Completion of Third Runway
- Year 2020 - Completion of Master Plan improvements

3.02 - APPROACH

The overall approach in the EIS Transportation Analysis involved four basic steps:

- Determine the existing operating conditions on the highway system in the communities surrounding the Airport using the traditional level of service (LOS) criteria. This traditional LOS criteria was also used by the Port of Seattle in the EIS. The base year was 1994.

- Determine the traffic impacts on this network during the construction of the Third Runway. This analysis focused on the heavy truck traffic generated by hauling the fill material. Impacts of alternate haul methods and other activities of the contractor and suppliers during the construction of the Third Runway also were assessed. The analysis period was 1994 to 2000.

- Determine the traffic impacts after construction of the Third Runway and during implementation of the full Master Plan. This analysis period was 2000 to 2020.

- Develop a staged mitigation plan that addresses the impacts of the proposed full Master Plan Update for each of the following three project phases:

  - Mitigation of existing traffic impacts created by current operations of Sea-Tac International Airport.
  - Mitigation of impacts during construction of the Third Runway.
  - Mitigation of impacts after construction of the Third Runway on a continuing basis through implementation of the full Master Plan Update.

A key element of this phased mitigation plan for traffic and transportation impacts will be Interlocal Agreements which will form the basis for a continued involvement as the full Master Plan Update is implemented.

Table 3.01 shows the EIS chapters which were evaluated as part of the transportation analysis.

Table 3.01
EIS Chapters Reviewed for Transportation Issues

Chapter	Section	Title
--	--	Executive Summary
I	--	Project Background and Purpose and Need
II	--	Alternatives
III	--	Affected Environment
IV	15	Surface Transportation
IV	23	Construction Impacts
V	--	Probable, Unavoidable, Adverse Environmental Impacts and Mitigation Measures
Appendix J	--	Surface Transportation Construction Impacts Report
Appendix O-A	--	Surface Transportation Report
Appendix O-B	--	Revised Surface Transportation Report
Appendix O-C	--	On-Airport Surface Transportation Report

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

3.03 - STUDY AREA

The study area for the traffic impact analysis included the jurisdictional boundaries of the cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila. The study area also included the facilities operated by the Highline School District and the Highline Community Hospital District.

While this study area represents the limitations of the impact analysis, the Sea-Tac International Airport has an influence on the transportation systems within the Puget Sound Region and the State of Washington. This influence can be seen in an analysis of trip origins to the airport and will be felt on a regional level during the construction of the Third Runway since the truck haul route impacts extend along the entire route from the Airport to the borrow source.

An analysis of the origin destination information provided in the EIS as well as the 1991 study data provided by the Evans-McDonough Company for the Port of Seattle:

- Approximately 73% of trips to Sea-Tac International Airport are local and the remaining 27% are made by visitors.

- Of the local trips; 30% are from Seattle, 8% from Tacoma, 8% from Bellevue, 5% from King County outside the study area and the balance of 44% are from the remaining Puget Sound region.

- Of the visitor trips; 50% are from Seattle, 35% are from the City of SeaTac and the balance of 15% are from the remaining region.

It becomes readily apparent that the visitor trips are focused on the City of Seattle and City of SeaTac (where the hotels are) and the local trips are very diverse throughout the region.

It was also discovered that less than 6% of the total trips to the Airport are from the five cities within the study area; however, the traffic impacts tend to be concentrated in these five cities which is near the trip-end. The sole exception is the City of SeaTac which bears the heaviest traffic burden (but is not part of the study area).

3.04 - KEY CONCERNS

During this study, many issues were raised by agencies, organizations, groups and individual citizens regarding the impacts of the Airport Master Plan implementation on the highway system. These issues can be grouped into four categories of concern:

- Potential congestion on local streets expressed in reduced levels of service, increased accidents, parking and pedestrian problems, impacts on school bus operations and crossings, impacts on the efficient operations of police, fire and safety equipment and an increase in delay on transit operations.

- There is a general concern for potential physical damage to the highway system, not only on the local street network, but also on the State network due to increased volume of heavy truck traffic, the resultant lowering of legal bridge load limits and increased maintenance expenditures.

- There is a major concern regarding potential impacts on the highway system during construction of the Third Runway particularly along the main truck haul routes. As heavy truck volumes increase on the main haul routes, which are expected to be the freeways, there is a concern regarding diversion of traffic off the freeways to the local street system. A parallel major concern are the alternate haul methods being considered by the Port of Seattle; such as the Des Moines Creek barge and conveyor system. Construction work-force activity by the contractor and concurrent construction projects are also of concern.

- There is a concern regarding the potential lingering impacts caused by construction of the Third Runway and the ultimate implementation of the full Master Plan expressed in additional traffic on the local street network due to increased operations at the Airport and an increase in the operation and maintenance costs on the local streets.

3.05 - EXISTING TRAFFIC CONDITIONS

The first step in developing the mitigation measures discussed further in Section 8 was to assess the existing conditions and mitigate those existing impacts. This then becomes the base condition where existing impacts have been addressed thus allowing a wide range of future alternatives to be assessed and effectively mitigated without base condition influences.

The base year in the Sea-Tac International Airport EIS was 1994. This is also the base year chosen for the mitigation plan. The Sea-Tac International Airport EIS contained very limited traffic data which would allow a local network assessment of the impacts. The data collected and the analysis performed in the EIS was well done for 12 major intersections which surround the Airport and form the Airport's entry points or "driveways".

An analysis was not performed in the EIS on any segments of highway connecting these major intersections; however of more consequence, there was no data collected or analysis made of existing traffic impacts on the local network on outside this initial investigation of the entry points.

Traffic volumes into the Airport in 1994 are reported in the EIS as 75,000 AADT (average annual daily traffic) which is projected to increase to 130,000 AADT by the Year 2020 - an increase of over 70%. The local street system will be impacted by this increase; however, an analysis of that impact in sufficient detail has not been made. The Port of Seattle's analysis at the 12 entry points surrounding the Airport show that the intersections that were failing in 1994 (Level of Service "F") are also LOS "F" in 2020. However, the 70% increase in traffic must be absorbed by the State and local street system in the surrounding communities, since only so much traffic can pass these "failed" intersections in a given amount of time. The impact of this 70% increase in traffic on the surrounding street system has not been done, but must be completed as part of mitigation planning.

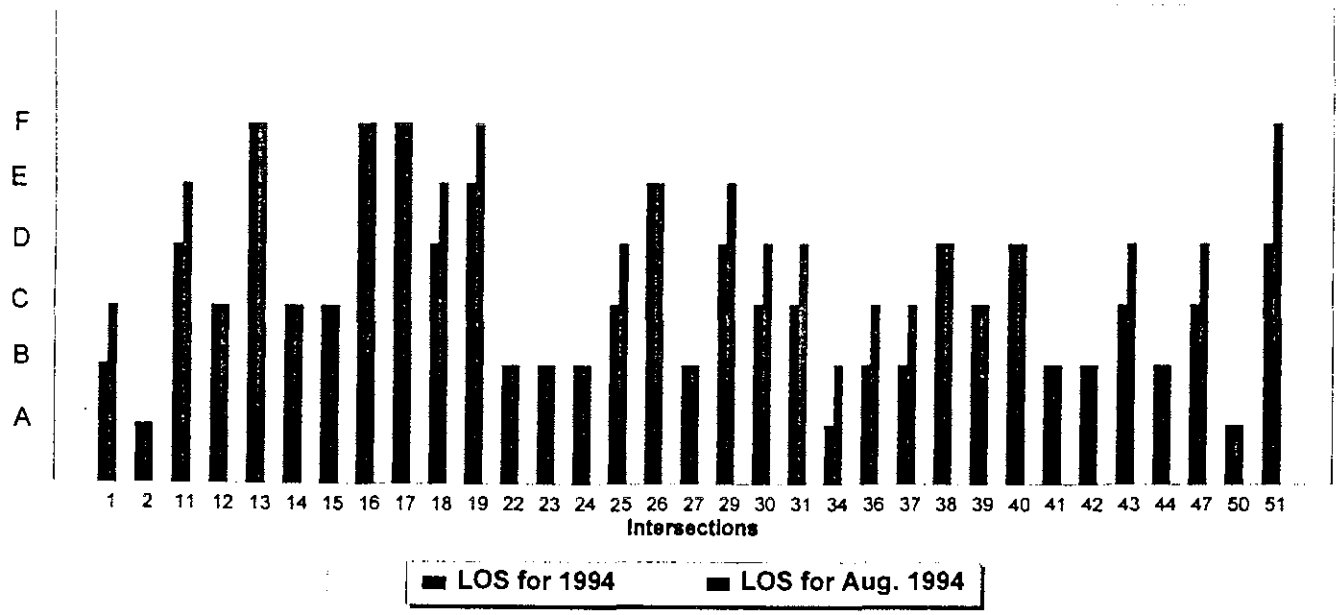
The 12 entry points/intersections evaluated in the EIS included 51 legs of these intersections. The EIS concluded that 20% of these intersection legs were currently failing, LOS "E" to "F" and another 30% were currently at capacity (LOS "C" to "D"), and could not handle more traffic without failing (see Table 3.02 and Figure 3.01). As expected, the failing intersections are on the east side of the Airport (City of SeaTac). The remaining 50% are currently operating at acceptable levels of service (LOS "A" to "B") and are on the west side of the Airport.

Table 3.02
1994 AADT/August Weekday Condition

Intersection Number and Name	1994 AADT Conditions			1994 August Weekday Conditions		
	Critical V/C	Average Delay (sec./veh.)	Level of Service	Critical V/C	Average Delay (sec./veh.)	Level of Service
1) SB SR 509 ramps at SR 518	0.764	10.7	B	0.846	15.0	C
2) NB SR and ramps at SR 518	0.614	1.8	A	0.713	2.3	A
11) SR 99 and South 154th	0.817	34.8	D	0.943	48.5	E
12) SR 99 and South 160th	0.586	21.1	C	0.667	22.6	C
13) SR 99 and South 170th	0.923	60.8	F	1.080	105.6	F
14) SR 99 and South 176th	0.496	18.8	C	0.572	19.5	C
15) SR 99 and South 180th	0.636	15.9	C	0.772	20.0	C
16) SR 99 and South 188th	1.154	247.4	F	1.326	406.8	F
17) SR 99 and South 192nd	---	---	F	---	---	F
18) SR 99 and South 200th	0.788	37.7	D	0.908	48.5	E
19) SR 99 and SR 516	0.687	49.4	E	0.802	70.3	F
22) 24th Ave. South and South 154th/156th	0.627	8.1	B	0.778	10.5	B
23) Des Moines Mem. Dr. and South 156th	0.563	7.6	B	0.710	6.9	B
24) Des Moines Mem. Dr. and South 160th	0.381	6.8	B	0.443	7.0	B
25) NB SR 509 ramps at South 160th	---	---	C	---	---	D
26) SB SR 509 ramps at South 160th	---	---	E	---	---	E
27) Air Cargo Rd. and South 160th	0.464	5.1	B	0.534	6.5	B
29) Air Cargo Rd. at SB Airport Exp. ramps	---	---	D	---	---	E
30) Air Cargo Rd. and South 170th	0.759	15.8	C	0.873	24.3	D
31) NB Airport Exp. and South 170th	---	---	C	---	---	D
34) SB SR 509 and South 188th	---	---	A	---	---	B
36) Des Moines Mem. Dr. and South 188th	0.661	12.6	B	0.755	15.0	C
37) 28th Avenue South and South 188th	0.783	12.6	B	0.840	15.9	C
38) Military Road and South 188th	0.749	27.9	D	0.857	36.2	D
39) SB IH-5 ramps and South 188th	0.546	15.0	C	0.624	16.2	C
40) NB IH-5 ramps and South 188th	0.704	28.1	D	0.812	35.7	D
41) Des Moines Mem. Dr. and South 200th	0.866	9.1	B	0.873	13.7	B
42) Des Moines Mem. Dr. and Marine View	0.447	8.3	B	0.510	8.6	B
43) 28th Avenue South and South 200th	---	---	C	---	---	D
44) Military Road and South 200th	0.562	8.2	B	0.710	9.4	B
47) Military Road and NB IH-5 ramps	---	---	C	---	---	D
50) 28th Avenue South and South 192nd	0.536	3.6	A	0.615	4.4	A
51) SB IH-5 ramps and SR 516	0.915	27.6	D	1.020	75.7	F

(Source: US Department of Transportation, Federal Aviation Administration and Port of Seattle, February 1996)

Figure 3.01
Level of Service Analysis by Intersection Number



Over time, as the Third Runway is constructed through the Year 2000 and the full Master Plan is implemented through the Year 2020, those intersections west of the Airport also will decline in level of service.

Existing trips (1994) to the Airport are generally oriented in north-south flow with 70% of the trips coming from the north 20% coming from the south and the balance 10% spread among the communities on the east and west. This strong orientation of trip-making makes the development of an effective Mitigation Plan much easier once traffic forecasts are extended beyond the 12 entry points surrounding the Airport.

There is a potential for increased vehicle accidents during the construction phase. The large number of heavy haul trucks will impact the current mix of vehicles on the roadway which will tend to increase the severity of the accidents and could also increase the frequency if the haul trucks were uncontrolled along the route.

Washington DOT accident data was made available for the SR 509/SR 518 interchange providing statistics on 548 accidents over the past 16 years which averages three accidents per month. This is the interchange which the haul trucks currently use for construction of the apron extension at the south end of the Airport. Over these 16 years, there has been no fatal accidents primarily because this interchange area is signalized and vehicle speeds are low at the time of the accidents. As one would expect, 75% of these accidents were angle-type (vehicles turning into each other), and the balance are predominately rear-end collisions.

3.06 - CONSTRUCTION IMPACTS

The EIS estimates that it will take three years to complete the embankment (fill) for construction of the Third Runway which will be completed in 2000. Over this three-year period, the EIS estimates 20 million cubic yards (MCY) of fill will be transported to the site. An additional 3 MCY will be needed to complete the full Master Plan improvements; although, that haul will be over the 2000 to 2020 time frame and should not become an issue on the highway system unless the haul is focused into a single construction season. However, the hauling of this additional 3 MCY should be part of any Mitigation Plan Agreement.

Eighteen borrow sites were identified in the EIS as potential sources of fill material. It is possible and likely that material will be transported from multiple sites depending on the contracting procedures of the Port of Seattle and market conditions at the time of contract bidding. Since it is not possible to either predict or control the borrow sources site(s), a Mitigation Plan Agreement must be developed to address impacts which arise from all potential sites. Of these 18 sites, 15 are south of the Airport, 2 are north and 1 is east. There also have been reports of borrow sites that would use Puget Sound as a transport route enabling borrow sites west of the Airport and in Vancouver to become economically feasible.

Hauling of 20 MCY by truck is a concern of the potentially impacted communities regarding safety, congestion and physical damage to their street network. This hauling operation would average 109 single bed trucks per hour in each direction or approximately 2,336 trucks per average day. By contrast, the current apron expansion contract moves 0.45 MCY or approximately 3% of the fill to be moved for construction of the Third Runway. The apron contract uses 10 trucks per hour, 6 days per week for 22 weeks, and is a source of controversy within the surrounding cities, including the City of SeaTac.

Due to the large volume of fill material to be hauled for construction of the Third Runway, double-bed and larger trucks are certain to be in the mix of general traffic. While the number of these larger trucks will be less, (109 singles - equivalent to 55 doubles or 36 triples) the operational characteristics and additional weight of these larger trucks are not directly proportional to the impact they will have on traffic operations and physical damage to the highway system. The Mitigation Plan must consider the impacts caused by the maximum permit weights allowed by Washington DOT and local ordinances.

Due primarily to economic factors as opposed to community opposition, alternate methods have been, and are being, explored by the Port of Seattle to haul 20 MCY to the site. One of the most discussed is a barge and conveyor system that would transport fill material by barge on Puget Sound to a newly constructed off-load facility at the mouth of the Des Moines creek and transfer material to an above ground conveyor belt that would run along the Des Moines creek sewer right-of-way three miles to the Airport property where on-site equipment would transport it to the construction site. Such a concept has been proposed to the Port of Seattle by the Westco Company. The primary advantage of this barge/conveyor system is that it will complete the haul in 18 months - a 50% time-savings over truck hauling.

There are other non-traffic alternatives being considered, such as barge transport along the Duwamish Waterway and transfer to a four-mile conveyor running along SR 509 and rail transport to the former long-acres site in Tukwila and transfer to a three-mile conveyor along IH-405/SR 518 with a tunnel under IH-5. In October 1996, the Port of Seattle released a Draft report entitled *Fill Material Alternative Delivery Method Study for the Third Runway* which considers the economic feasibility of these and other haul alternatives. This particular study ranks the alternatives as follows:

1) Barge to the Duwamish Waterway and truck along SR 509 to the Airport.
2) Trucking only.
3) Barge to Des Moines Creek and conveyor to the Airport.

Before the actual construction begins, there will be additional alternatives proposed with varying impacts to the communities. While the market conditions will influence the final decision, the impacted communities must have a Mitigation Plan Agreement in place prior to the haul that will address the impacts of that particular alternative, participate in the discussions and issue the necessary local permits. The Mitigation Plan must not only address the impacts of the truck and non-truck methods, but also be flexible enough to address changes proposed by the contractor during construction.

3.07 - POST-CONSTRUCTION IMPACTS

While the impacts during the construction phase would be mitigated through 2000, there will be additional impacts created by implementation of the full Master Plan between 2000 and 2020, including construction of the north unit terminal, cargo warehouse, the Runway 34R extension, gate expansions and expansion of the parking garage. Airport traffic is projected by the EIS to increase from 75,000 AADT in 1994 to 84,000 AADT in 2000, a 12% increase and to 130,000 AADT in 2020 a 55% increase over 2000. This 55% increase in traffic will be the focus of the Post Construction Impact Mitigation Plan. In the EIS analysis, the level of service decreased on 20 of the 51 intersection legs (40%) evaluated by the Year 2000. The impact of this reduction in level of service should be addressed in the Construction Phase Mitigation Plan, to be developed by either the Port of Seattle or its contractor. By the Year 2020, 80% of the legs have decreased levels of service which should be addressed in a Post-Construction Mitigation Plan.

Currently, parking for Airport operations is concentrated on Airport property and along SR 99 in the City of SeaTac. The Master Plan provides for additional required parking to be on Airport property or on the eastside of the Airport. Parking operations and impacts are therefore not part of the current Mitigation Plan; however if parking issues become apparent in the future, the Mitigation Plan Agreement will provide the mechanism to address them.

There would be associated increased operation and maintenance costs to the surrounding communities on the local street system. These would be assessed as part of Mitigation Plan in all three phases - base condition, construction and post construction.

3.08 - FINDINGS

In the EIS, the Port of Seattle made efforts to consider other proposed improvements to the Regional Transportation system within their planning for implementation of the full Master Plan. This is the appropriate approach. The regional projects considered in the EIS were as follows:

- Completion of the proposed regional transit authority (RTA) system.
- Completion of the proposed high-occupancy vehicle (HOV) system.
- Completion of the proposed SR 509 extension.
- Completion of the proposed Southern Airport Expressway.

Each of these regional transportation projects will move forward with varying schedules. The effect of including these four regional projects in the Year 2020 traffic forecast is to underestimate the impacts on the local street systems. Because it cannot be determined at this time which of these regional projects will be implemented and when, a Year 2020 forecast should be made without these projects to assess the worse case impacts on the local street system.

While the intersection analysis performed in the EIS was well done, the number of intersections studied was limited to the access "driveways" or entry points surrounding the Airport. Currently the heavy traffic impacts are east of the Airport (City of SeaTac); however, over time those heavy impacts will be felt throughout the surrounding area. There was minimal analysis performed in the impacted communities. A comprehensive area-wide traffic study needs to be prepared in order to assess potential impacts to the local street system in a comprehensive manner. This need is further indicated by the forecast of a 70% increase in Airport traffic and accompanying 80% decrease in traffic level of service by the Year 2020.

Based upon the EIS forecast of the fill requirements of the Third Runway, a convoy of haul trucks will be necessary in the peak periods of one truck every 30 seconds, 500 yards behind each other for three years. This a staggering statistic. For this reason doubles, triples and maximum weight carriers will be employed to contain the costs of transporting the fill material. The only highway type capable of handling this volume of heavy trucks is the regional freeway system with the Interstate Highways being the best prepared to handle this demand. If the fill material is transported by truck, the haul trucks must remain on the freeway system, be subject to operational restrictions by the DOT and access the construction site via a direct connection between the freeway system and the site. The area along SR 518 and the northern Airport boundary offers such an opportunity for this direct connection which could operate as a temporary construction entrance and be dismantled after completion of the contract.

There has been no analysis made of potential physical damage to the highway system, particularly the bridge decks, of this heavy truck volume in the EIS. This includes both the State and local highway systems.

While the context of this impact analysis is the communities immediately surrounding the Airport (excluding the City of SeaTac). The analysis of potential physical damage should be conducted along the entire fill haul route(s).

From the potential burrow sites to the Airport, the barge/conveyor system alternate avoids the physical damage and congestion on the highway system and would physically complete the haul in less time than the trucking alternate; however, there are potentially severe environmental impacts associated with this system along Des Moines Creek. There is the potential for spillage of material into Puget Sound along the route and at the transfer pier, above ground conveyor noise and visual impacts, loss of recreational use of the corridor during construction, safety issues with people, and the restoration of the entire corridor upon completion of the operation.

While traffic volumes in the areas surrounding the Airport is forecast to increase by 70% with corresponding decrease in highway level of service of 80%; not all of this increase/decrease is due to construction of the Third Runway or other Master Plan projects. Also included in this traffic are local trips, regional trips, shopping trips, work trips, recreation trips, etc. The approach that must be taken in the Mitigation Plan is to determine the actions necessary to mitigate the entire impact, determine the costs associated with mitigation the particular impact and finally, to the best extent possible, allocate these costs among the various parties in a responsible and equitable manner. This equitable distribution or *pro-rata* share has not yet been determined but should be a key element of the Mitigation Plan. Preliminary indicators in the EIS traffic figures point to a pattern of 33% of traffic on SR 518 is Airport traffic, 50% of all southbound traffic on SR 99 volume is Airport traffic and 25% of northbound SR 99 volume is Airport traffic. This is, of course, not reliable enough to base a cost allocation model upon; however, such a model must be prepared. This effort also would include an updated origin-destination study and a select link/screen line analysis along the principal arterials on an area-wide basis surrounding the Airport. The 1984 O-D study by the Port of Seattle is not adequate to develop this cost allocation model.

SECTION 4

EIS SOCIO-ECONOMIC ANALYSIS

SECTION 4
EIS SOCIO-ECONOMIC ANALYSIS

4.01 - INTRODUCTION

The impacts of an airport on a region's socio-economic environment manifest themselves through indirect and induced effects - unlike an airport's physical and biological impacts which impress themselves directly on the natural environment. This is true both for an airport's beneficial and adverse impacts.

In terms of an airport's beneficial impacts, the FAA defines the benefits to a community of an airport as including direct benefits, indirect benefits and induced benefits. In Butler and Kiernan (September 1996), the FAA states:

> *"The primary [transportation] benefits of an airport are usually the time saved and cost avoided by travelers who use it over the next best alternative"*; . . . . and the resulting *"economic activities [measured in terms of employment and income] that would not have occurred in the absence of the airport."*

In these definitions of airport beneficial impacts, it is not the Airport itself but the social and economic consequences of the Airport, measured in time savings and business activity, that generate the impacts. Specifically, there are three types of benefits - Direct, Indirect, and Induced:

- **Direct Benefits** - Defined as the time and cost saving to travelers compared with alternative modes of transportation and the jobs, income and business activity generated at the airport.

- **Indirect Benefits** - Defined as the jobs, income and business activity generated by companies that are not at the Airport but are users of, or closely linked to, aviation transportation services.

- **Induced Benefits** - Defined as the jobs, income and business activity generated by multiplier effects from inter-industry linkages to direct and indirect impact companies.

In line with the FAA's analysis of how airports generate beneficial impacts, the 1994 report, *The Local and Regional Economic Impacts of the Port of Seattle* (Martin O'Connell Associates, 31 May 1996) measures 4 types of impacts - jobs, personal earnings, business revenue and taxes paid. It estimates the direct job benefits to be 38% of the total. Equivalent measurement techniques have been used to estimate similar airport beneficial impacts both elsewhere in Washington State (Thomas/Lane & Associates, June 1991) and throughout the country (Hewings, et.al. 1995).

Similar to beneficial impacts, an airport's adverse impacts have a direct component but are primarily the result of indirect and induced effects. This Section defines and discusses the different types of adverse impacts produced by airports, and the significance of these impacts for the communities that lie within Sea-Tac International Airport's adverse impact area.

4.02 - DIRECT ADVERSE SOCIO-ECONOMIC IMPACTS

Direct adverse impacts of commercial airports on surrounding communities are measured by the decline in residential property values compared to what they would have been if the Airport were located elsewhere in the metropolitan area.

Airports generate noise, visual blight, surface traffic congestion, air pollution and other effects which cause most households to consider the areas immediately surrounding them to be less desirable places to live. Some households may have a primary wage earner employed at (or near) the Airport and consider the reduction in commuting time a more than off-setting factor to the Airport's direct adverse impacts. For others, there may be neighborhood or individual house characteristics that off-set the Airport's direct adverse impacts. But for most households, close proximity to an airport reduces a property's residential desirability. (Crowley, 1973). As a result, a residential housing unit located close to an airport will normally have a market value less than it would have had if located elsewhere in the region, other things (such as lot size and view) being the same.

Most studies of direct adverse impacts of airports have concentrated on measuring the noise impacts on property values (Newman and Beattie, 1985; Frankel, 1991; and Mieszkowski and Samper, 1978). A recent report by Booz-Allen & Hamilton, Inc. (September 1994), prepared for the FAA, reported:

> *"Impacts on property values of airport noise varies from negligible [$627 for lower priced housing units around Baltimore International Airport] to significant [$60,873 for moderately priced housing units around Los Angeles International Airport] and appears to be more pronounced in higher priced neighborhoods."*

A *Sea-Tac Airport Vicinity Land Use Inventory Project* report prepared for the Port of Seattle in 1994 looked at the noise issue by comparing the assessed values of 32 residences located within Sea-Tac International Airport's "Noise Remedy Area Boundary - 16 residences were within both the Airport's 65 LDN and Noise Remedy Area boundaries and 16 residences were outside the Airport's 65 LDN boundary but within the its Noise Remedy Area boundary (Shapiro and Associates, April 1994). For a variety of methodological and research procedure issues (the most notable being the lack of comparison between houses near to the Airport with comparable units in other parts of the central Puget Sound region), the report concludes (page 55):

"Given the limitation of this study, neither the existence nor the magnitude of any general effect on rates of appreciation of property values from airport noise is demonstrated."

The Airport's direct impacts primarily result in private costs, which are measured as the decline (or reduction in the rate of growth) of privately owned residential property. This cost is borne by the property owner at the time the Airport is created or at the time the Airport undergoes a significant increase in the magnitude of its adverse impacts - such as occurred when jet airplanes came into wide spread commercial use.

Direct public costs are measured by the decline in the local tax base that results from the reduced (or more slower growing) property values of residences in close proximity to the Airport.

4.03 - INDIRECT ADVERSE SOCIO-ECONOMIC IMPACTS

Indirect adverse impacts of commercial airports on surrounding communities are measured by the change in residential and business land uses that result from the decline in property values (or the decline in the rate of increase of property values) caused by the airport's direct impacts. The importance of indirect effects is that they are the intermediary through which direct impacts lead to induced impacts - and as will be discussed below, there are significant costs associated with induced impacts. Indirect impacts occur only at the community level and generally there are no private indirect costs.

An individual household or business that observes a relative decline in the value of land directly impacted by Sea-Tac International Airport will make a decision about changing land use to maximize its household welfare. From the perspective of the community however, the result of these individual welfare maximizing decisions is:

- An increase in single family residential rentals and the development of multi-family rental properties;
- A shift in a community's population from primarily home owners to a mix of stable home owners and more transient renters;
- The growth of business activity whose market is the more transient rental population; and,
- Resistance by impact area residents to pass levies needed for city and school district operations.

The net effect of such indirect effects is to produce significant induced adverse impacts in the 5 cities immediately surrounding Sea-Tac International Airport that are the focus of this study.

4.04 - INDUCED ADVERSE SOCIO-ECONOMIC IMPACTS

Induced adverse impacts of commercial airports on surrounding communities are measured by both:

- Costs associated with community service requirements such as community centers, schools, nuisance abatement, child care, and public safety; and,

- Declines in a community's property tax base produced by altered demographic and business profiles that result from the airport's indirect (land use) impacts.

The manner in which Sea-Tac International Airport's induced impacts can result in a fiscal squeeze (increased service requirement costs and reduced property tax revenues) on local jurisdictions is illustrated by the Highline School District. Sea-Tac International Airport's direct and indirect impacts produced lower relative land values, increased rental properties and a change in the District's population profile to include more transient (i.e.: renter) households with lower incomes. The close association between higher/lower income households and owner/renter occupancy status has been documented in a report entitled *Washington Housing Needs* Study (1986, prepared for the State of Washington Department of Community Development by Thomas/Lane & Associates, Phillips Associates, and Raj Joshi Associates).

The children of the lower income renter households, on average, require a higher level of service from the district's schools to achieve the same outcome - whether outcomes are measured in Washington's uniform test scores, percent of high school graduates continuing on to higher education, SAT scores of high school seniors, or any other generally recognized measure of academic performance (Ward and Krueger, 1996). At the same time the District experiences these increased service requirements and incurs the cost increases of providing additional service to achieve constant school outcomes, its tax base is reduced because of the decline in relative land values caused by the Airport.

A similar pattern of causality exists between Sea-Tac International Airport's direct and indirect impacts and its induced impacts (as measured by their costs) on public safety, child care, senior centers and other types of community services.

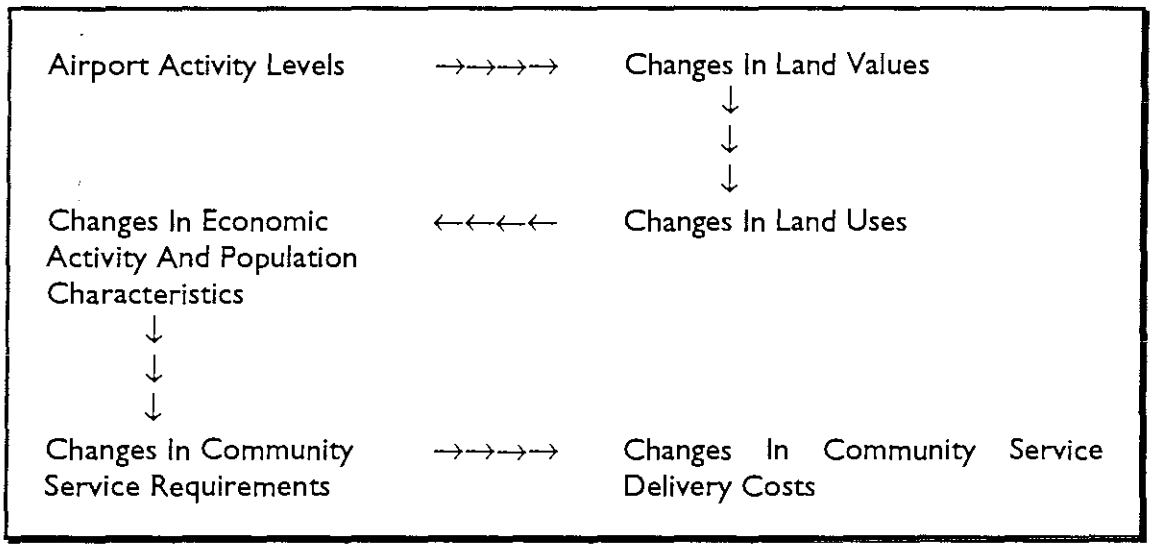
4.05 - TOTAL SOCIO-ECONOMIC ADVERSE IMPACTS

Sea-Tac International Airport's total socio-economic impacts are the sum of it direct, indirect and induced socio-economic impacts. This is true equally for the Airport's beneficial and adverse impacts. The requirement for mitigation of adverse socio-economic impacts occurs when the Airport's adverse impacts are greater than its beneficial impacts. In a global context, the relationship between Sea-Tac International Airport's total socio-economic beneficial impacts and adverse impacts is theoretically analogous to a socio-economic benefit/cost analysis.

Analyzing socio-economic mitigation requirements however, involves an analysis that is community specific. Sea-Tac International Airport's total benefits may exceed its total costs, but (as discussed in Appendix A) its benefits are widely distributed over the multi-county central Puget Sound region while its adverse impacts are concentrated in communities immediately surrounding the Airport. From the perspective of these communities, the Sea-Tac International Airport's adverse impacts far exceed its benefits; and the difference between the two represents the appropriate level of required socio-economic mitigation.

The sequence of causally linked steps that generate adverse socio-economic impacts for a community is illustrated in Figure 4.01.

Figure 4.01
Adverse Socio-Economic Causality



The relationship between direct, indirect and induced socio-economic beneficial and adverse impacts is shown in Table 4.01.

Table 4.01
Definition and Measurement of Airport Master Plan Update Impacts

Type of Impact	Adverse Impact		Beneficial Impact	
	Definition	Measurement	Definition	Measurement
Direct	Blighting of land values In the five cities in immed-iate proximity of Sea-Tac's approach/depar-ture flight tracks	Decreases in value of residential land in the five cities immediately surrounding the airport over what it would have been if there was no airport	Economic activity occurring at Sea-Tac that would not occur in the absence of the airport's expansion and the time saving to travelers who use the new facilities	Number of jobs and amount of business and worker income generated at Sea-Tac as a result of the airport's expanded facilities
Indirect	Changes in land uses in the five cities immediate-ly surrounding Sea-Tac	Down scaling of socio-economic characteristics of both businesses and population groups in the five impacted cities immediately surrounding Sea-Tac	Off-airport economic activity among companies that are users of, or closely linked to, aviation services that would not occur in the absence of the airport's expansion	Number of new jobs and amount of new business and worker income generated by companies that are users of or are closely linked to aviation transportation
Induced	Increase in community services (public safety, schools, nuisance abatement, community centers) needed to maintain constant quality of life in the five impacted cities immediately surrounding Sea-Tac	Cost of delivering the community services (public safety, schools, nuisance abatement, community centers) required to maintain constant quality of life in the five impacted cities immediately surrounding Sea-Tac	The multiplier affects of Sea-Tac's direct plus indirect impacts - i.e., increases in employment and income (over and above the combined direct plus indirect impacts) created by successive rounds of spending	Number of additional jobs and amount of additional business and worker income generated by multiplier affects from inter-industry linkages of directly and indirectly impacted companies and households

(Source: FAA Document DOT/FAA/PP-92-6)

4.06 - BALANCING SOCIO-ECONOMIC COSTS AND BENEFITS

It is widely recognized that airports generate a range of socio-economic impacts. For example, FAA Advisory Circular AC 150/5020-1, *Noise Control & Compatibility Planning for Airports*, states on page 6 that:

> *"Many [environmental assessments] contain analysis of airport noise, compatible land use, social impacts, and induced socioeconomic impacts."*

In Section 6 - Analysis of Costs and Benefits and Selection of an Alternative (page 42), the FAA Advisory Circular states:

> *"Evaluation of the social costs and benefits of the alternatives is of equal importance with those of economics and the environment."*

Some costs adversely impact the quality of life in communities - primarily communities immediately surrounding the Airport which suffer the air pollution, visual pollution, noise pollution and surface traffic congestion produced by Airport operations. Others beneficially impact the quality of life of communities in the region - primarily communities where jobs, income and business activity are created and where local residents frequently use air transportation services.

Among researchers who have studied the decline of urban environments, the growth of airports is considered, along with facilities such as toxic waste dumps, an environmental hazard.

A recently published study by Rutgers University professors Michael Greenberg and Dana Schneider reports:

> *"Airports are associated with traffic jams, airplane crashes, and extraordinarily high levels of noise. When present, low-flying aircraft are an even more distressing source of noise than motor vehicles on highways. Jets, especially jumbo jets that cannot rise quickly, create an extremely high decibel level and a whining sound upon takeoff. Unlike a highway where the noise is relatively continuous and can often be masked by sound barriers and air conditioning, airport noise is discontinuous and is virtually impossible to mask. In addition to task interference and uncontrollable physiological changes observed in people living near highways, those residing near airports suffer from feelings of helplessness and lack of control."*

A modern growing economy appears to require the services of an international airport, but the provision of air transportation services produces adverse as well as beneficial impacts. As is true with all airports, Sea-Tac International Airport's socio-economic impacts are not distributed uniformly over the region, nor are its benefits and costs distributed proportionately among communities. An analysis of appropriate mitigation consequently requires a community by community assessment of the Airport's net socio-economic impacts.

4.07 - ANALYSIS OF EIS'S "NO ACTION" ASSUMPTION AND THE IDENTIFICATION OF AIRPORT ACTIVITY LEVELS LIKELY TO RESULT IN FUTURE LAND VALUE CHANGES

The *Airport Master Plan Update for Seattle-Tacoma International Airport* was completed in 1996 (P&D Aviation, January 1996) and its findings and forecasts are the basis for Sea-Tac International Airport's proposed expansion, including construction of the Third Runway. The *Airport Master Plan Update* forecasts are also the basis upon which the Airport's *Environmental Impact Statement* (EIS) estimated the impact of Sea-Tac International Airport's Third Runway and related improvements.

The *Airport Master Plan Update* forecasts were:

> *"Prepared as an element of the Airport Master Plan Update to be used to develop airport facilities requirements and to estimate the time frames when future improvements are needed."* (P&D Aviation, 20 August 1994)

The objective of the *Master Plan Update* forecasts was:

> *"To develop updated master plan forecasts which can account for a range of potential future airport scenarios and provide a sound basis for guiding the development of future facility improvements at the airport. Accordingly, the forecasts ... are planning level estimates and are not intended to be exact predictions."* (P&D Aviation, 20 August 1994)

The approach to, and purpose of, forecasting contained in the *Master Plan Update* is consistent with FAA guidelines, which state:

> *"The purpose of aviation forecasts is to indicate the relative timing for airport investments in a manner that minimizes forecast error costs. The idea is to forecast the different elements of aviation demand, compare that demand over time with the* ***capacity*** *[emphasis added] of an airport's various facilities, and to identify the time when new or expanded airport facilities may be necessary."* (Advisory Circular No. 150/5070-6A. US Department of Transportation, Federal Aviation Administration)

However, when using the *Airport Master Plan Update* forecasts that were the basis for recommended facilities expansions at the Airport, the Sea-Tac International Airport Master Plan Update Final EIS states in Volume 4, Appendix R (page R-5):

> *"If the proposed new runway and other* ***facility improvements*** *[emphasis added] are not constructed, the growth in demand for air travel would continue to occur as would the number of aircraft operations, because it is expected that the Region will continue to experience growth in population and income " ... and that it is reasonable to* ***assume for purposes of this environmental analysis*** *[emphasis added] that the same number of operations would occur with and without the proposed new runway."*

A disjunction exists consequently between the objective for which the Sea-Tac International Airport forecast was made and purpose to which it was put in the EIS.

The *Master Plan Update* generated a forecast, compared it with Sea-Tac International Airport's existing facilities and determined the Airport's facilities needed expansion. **The EIS used the same forecast and assumed it would occur without any facilities being expanded** at the Airport. The result of the EIS's assumption is that the Third Runway causes almost no socio-economic impacts since the same level of passenger enplanements, aircraft operations and cargo movements occurs whether or not facilities at the Airport are expanded.

As a result of this assumption, the *Sea-Tac Master Plan Update Final EIS* considers socio-economic impacts only from the perspective of residences and businesses that will be displaced by the Airport's expansion. The Final EIS (Section 6 - Social Impacts) reports that:

- 388 single family housing units, 260 condominiums/apartments, and 105 businesses will be displaced and will need to be acquired (assuming a 8,500-foot long Third Runway is built)

- All of the displaced housing units and businesses are located in the City of SeaTac, in the immediate periphery of the existing Airport.

- The Cities of Des Moines, Federal Way, Kent, SeaTac and other nearby communities contain adequate comparable housing, or developable land, to absorb the demand created by the housing displacements; although finding all of the replacement housing within the City of SeaTac is likely not possible.

- The Port of Seattle proposes to purchase avigation easements from commercial properties located within the Third Runway's runway protection zone (RPZ), unless they conflict with the FAA's RPZ safety guidelines - in which case they will be displaced and their properties acquired.

- Acquisition and displacement of existing residences would cause some disruption of community character, with disruption being greatest in the west City of SeaTac neighborhood between 12th Avenue South and SR 509,

- No minority, age, or income group will be disproportionately affected, and the intent of Executive Order 12898, "Environmental Justice" is therefore met,

- About 71% of the housing units and 91% of the apartments/condominiums to be acquired would be "affordable housing".

- And identified social impacts will be mitigated only by acquisition of properties at fair market value and payment of relocation benefits, as specified in the federal Uniform Relocation Assistance Act (US DOT, 49 CFR, Part 24).

The Final EIS (Section 8 - Induced Socio-Economic Effects) considers the impact of property acquisitions and displacements on employment, payroll, business expenditures, and the tax receipts of affected cities. It reports the following findings:

- The total assessed value of the property to be acquired is $75.4 million, of which $54.1 million is residential property and $21.3 million is commercial property.

- As a result of property acquisitions, total annual reductions in property tax receipts would be $227,600 - $45,900 per year in the City of Burien and $181,700 per year in the City of SeaTac.

- As a result of business displacements, the total annual loss in taxabale retail sales would be $2.2 million - $0.6 million in the City of Burien and $1.6 million in the City of SeaTac [the Final EIS did not calculate or report the actual loss of retail sales tax receipts].

- Businesses located on properties to be acquired employ a total of 627 workers - 40 in the City of Burien and 587 workers in the City of SeaTac.

- Identified impacts will be mitigated only by acquisition of properties at fair market value and payment of relocation benefits, as specified in the Federal Uniform Relocation Assistance Act (US DOT, 49 CFR, Part 24).

EIS Section 8 also evaluates the reasonableness of the Final EIS's assumption that passenger enplanements, aircraft operations and cargo movements at Sea-Tac will be unaffected by whether or not any facilities - including the Third Runway - are expanded/constructed over the 25-year period, 1995 and 2020. It also evaluates the reasonableness of the Final EIS's description of the socio-economic impacts that will be caused by the proposed expansion of Sea-Tac. Finally, it proposes a more likely scenario of the relationship between facilities expansion and aviation activity at the Airport.

4.08 - THE MASTER PLAN UPDATE FORECAST

The final Sea-Tac *Airport Master Plan Update* forecast report (Volume 5) projects the demand for aircraft operations (landings and take-offs) to grow as shown in Table 4.02. The *Airport Master Plan Update* report also forecasts the mix of aircraft flying into Sea-Tac will contain larger aircraft than are in use today, as shown in Table 4.03.

The demand forecast for carrier/commuter operations and for the use of larger aircraft results from the following forecast of passenger enplanement demand, 96% of which comes from persons enplaning domestic air carriers flying in and out of Sea-Tac (Table 4.04).

Table 4.02
Aircraft Operations Forecast

Operation	1993 (actual)	2000	2010	2020	Change 1993-2020
Air Carriers	188,000	223,000	255,000	287,000	+99,000
Air Taxis/Commuters	127,000	127,000	118,000	117,000	-10,000
All-Cargo Carriers	16,000	20,000	23,000	27,000	+11,000
GA & Military	8,000	9,000	10,000	11,000	+3,000
Total	**339**	**379**	**406**	**442**	**103**

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996, Volume 5, Table 5-15)

Table 4.03
Forecast of Aircraft Mix Flying Into Sea-Tac

Operation	1993 (actual)	2000	2010	2020	Change 1993-2020
Average Seats Per Air Carrier Aircraft	155	169	189	209	+54
Average Seats Per Air Taxi/ Commuter Aircraft	28	31	36	36	+8
% of All-Cargo Carriers Over 60,000 Pounds	64%	69%	75%	80%	+16%

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996, Volume 5, Table 5-18)

Table 4.04
Forecast of Enplaning Passengers

Enplanement	1993 (actual)	2000	2010	2020	Change 1993-2020
Domestic Air Carriers	8,100,000	10,100,000	13,000,000	16,300,000	+8,200,000
Domestic Air Taxis/Commuters	600,000	700,000	800,000	900,000	+300,000
Enplanements to Canada	400,000	600,000	900,000	1,100,000	+700,000
Other International Enplanement	300,000	500,000	600,000	800,000	+500,000
Total	**9,400,000**	**11,900,000**	**15,300,000**	**19,100,000**	**+9,700,000**

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996, Volume 5, Table 5-8)

Based on these forecasts, the *Airport Master Plan Update* report proposes numerous facilities improvements, including the following:

- A new 8,500 foot runway (the so-called Third Runway, or runway 16X-34X).
- A mid-field overnight parking apron between runways 16R-34L and 16X-34X.
- Limited expansion of 4 to 6 gates on Concourse A and the Main Terminal, including expansion of the Central Parking Garage.
- Development of a new north unit terminal.
- Development of a cargo warehouse.
- Construction of a new Air Traffic Control Tower and TRACON (terminal radar control area).
- Installation of a CAT III ILS (category 3 instrument landing system) on runway 16L.
- Extension of duel parallel Taxiways A and B the full length of runway 16L-34R and a taxiway bridge over 188th Avenue South.
- Extension of runway 34R by 600 feet and relocation of the glideslope.

The *Airport Master Plan Update* report finds operations levels will reach the Airport's capacity about the Year 2000, and therefore recommends that the Third Runway and the expansion of the Main Terminal at Concourse A be completed between the Years 2001 and 2005, with additional facilities expansions occurring between 2005 and 2020.

4.09 - OTHER AVIATION FORECASTS OF SEA-TAC'S CAPACITY

A report titled, *Air Transportation Demand, Aviation Industry Trends, and Air Capacity in Washington Through 2020* (TRA Consulting, October 1992), was prepared for the Washington State Air Transportation Commission (AIRTRACT). It calculated the service capacity or annual service volume (ASV) of Washington airports and reported:

> *"With 1991 operations at 365,000, Sea-Tac is close to capacity. According to the base forecasts, the ASV calculation of 380,000 operations will be reached between 1992 and 1993."*

The Final Report of the Puget Sound Council of Government's (jointly with the Port of Seattle) Puget Sound Air Transportation Committee (January 1995) also placed Sea-Tac's annual operating capacity at 380,000 operations.

A study titled, *Phase I Forecasts: Flight Plan Study*, conducted by KPMG/Peat Marwick (July 1990) for the Port of Seattle and the Puget Sound Conference of Governments in 1990 found that its forecast of 427,000 operations for the Year 2000, assuming no changes in Sea-Tac's runways and facilities would mean that:

> *"Annual average aircraft delays would approximate 10 minutes per aircraft operation. Average delays on the order of 10 minutes are experienced at the most congested airports in the United States, such as Chicago O'Hare International Airport, LaGuardia Airport, and Washington National Airport."*

O'Hare, LaGuardia, and Washington National are referred to as "slot controlled" airports where the FAA limits any increase in total operations during each airport's peak hours.

On 19 May 1992, P&D Aviation (the same consulting organization that prepared the *Airport Master Plan Update* for Sea-Tac) wrote a "Working Paper" for the Port of Seattle titled, *Analysis of Maximum Passenger Limits at* Sea-Tac *Airport Under the No New Runway Alternative*. The report estimated that the maximum acceptable delay would be an average of 22 minutes per aircraft operation, and it analyzed both non-structural methods by which the Airport could increase capacity and the likely airline response to increased delays. It concluded that the Airport would reach capacity somewhere between 2010 and 2012, but also concluded:

> *"Obviously an average delay of 22 minutes per operation would be a significant increase in delay and would have a large impact on Airport operations as well as overall passenger service."*

The Civil Tiltrotor Development Advisory Committee's *Report to Congress* (delivered in December 1995) contains a map reference to the FAA's Office of Policy and Plans which shows airports actually congested in 1993 and which are expected to be congested by the Year 2000. Sea-Tac International Airport is shown on the map as actually congested in 1993.

Finally, the *Final EIS for the Proposed Master Plan Development Actions* discusses Port of Seattle studies about Sea-Tac's capacity limits and reports that:

> *"The inability of existing airfield facilities to accommodate traffic into the 21st century was first recognized in the mid-1980s when the Port completed the Comprehensive Planning Review & Airspace Update Study. The purpose of the study was to assess the validity of previous plans developed for Sea-Tac in light of air travel growth and other changing conditions at the Airport. While previous plans had not indicated a need for new runway capacity, this new study showed that the existing runway system would not be capable of serving the increased demand past the Year 2000."*

All past studies, including the *Master Plan Update* study, conclude Sea-Tac's existing facilities cannot accommodate the operations, enplanements and cargo demands forecast for the Year 2020. Construction of the Third Runway, and related Airport improvements, are a necessary condition for expansion of Airport activity to the 2020 forecast levels.

In the absence of the Third Runway, and related Airport improvements, the number of annual operations contained in the forecast will not be reached. Airlines will raise fares for flights originating/departing Sea-Tac, shift flights to other airports in the region, discontinue short haul commuter operations and concentrate on long haul flights into/out-of Sea-Tac, or take other actions compatible with delay reduction and higher profit margins. If the average time delay per arriving flight forecast without the Third Runway and related Airport improvements occurs, there will be some reduction in use initiated by airlines flying into Sea-Tac, passengers using the Airport, or both.

While a full, detailed investigation of the relationship between Airport expansions and the growth of Airport activity is beyond the scope of the current work effort, a review of available data on major airports in the United States indicates that there are no cases of a major airport more than doubling its number of operations and enplanements and growing continuously over a period of 45 years without having major expansions in its "airside" and "landside" facilities. With Sea-Tac's last major facility expansion completed in 1975, this is the scenario assumed in the EIS.

Additionally, the forecast equations contained in P&D's *Final Forecast Report* are not compatible with the assumptions made in the EIS. P&D's primary domestic forecast equation says that Sea-Tac's domestic enplanements are positively related to personal income in the Puget Sound Region and negatively related to domestic airfares (page 5-6, *Final Forecast Report*). When personal income in the region goes up, domestic enplanements rise; when domestic fares go up (in constant value dollars), domestic enplanements fall. P&D's primary international forecast equation says Sea-Tac's international enplanements are positively related to gross state product in the 3-state area–also in constant value dollars (page 5-11). When the 3-states' gross state product rises, international enplanements rise. The importance of these equations is that the two variables positively related to enplanements at Sea-Tac are also measures of economic growth and business activity in the Puget Sound Region and the 3-state Pacific Northwest area. Hence the P&D forecasting equations state that when business activity declines, activity at the Airport falls.

There is widespread agreement that Sea-Tac is an important contributor to economic and business growth in the Puget Sound Region and the Pacific Northwest. The implication of this position however is that if the Third Runway (and related facilities) are not built, future economic growth and business activity will be adversely affected; gross state products and regional personal income will decline; and enplanements and operations at Sea-Tac will fall.

The problem with the EIS is that it assumes that even if the Airport is not expanded, there will be no fall in Airport activity. Since the EIS is based on P&D's *Master Plan Update Study*, it has to accept the equations on which the study's forecast is predicated. The EIS consequently assumes implicitly that expansion of the Airport has no influence on future economic conditions in the Puget Sound Region or the Pacific Northwest.

Again, the EIS's assumption is difficult to maintain. First, there is a professional/technical consensus that the growth/expansion of major airports is associated with the economic health of metropolitan regions, and this is true whether one argues that airports are causal or responsive to economic activity. Second, if the expansion of the Airport has no relationship to business activity - as reflected in either personal income or gross state product - what is the rationale for undertaking the major costs and disruptions that will be required. If the behavior of the business community does not change and the non-business traveling public flies the same amount with or without the Third Runway, as the EIS also assumes, why build it? The answer, clearly, is that the business community will be adversely affected, and that airlines may be forced to raise fares at Sea-Tac if they are confronted with the delays indicated in the P&D forecast and analysis; and that both of these consequences will cause enplanements and operations at Sea-Tac to decline. Which is to say, the EIS's assumption is methodologically flawed. As a result it is not compatible with either public statements made by the Port that link Sea-Tac to the region's and area's economic growth or the analysis of socio-economic impacts developed as part of the Sea-Tac Impact Mitigation Study.

The EIS says one thing while the *Update* study equations say another. The socio-economic analysis contained in the Sea-Tac Impact Mitigation Study takes the position that the forecasting equations contained in the P&D analysis are appropriate and the Airport is positively associated with the rate of economic growth in the Puget Sound Region and Pacific Northwest. This leads to the conclusion that if the Third Runway is not built, business activity will be adversely affected, personal income and gross state product will not grow as fast as otherwise, and enplanements and operations will be consequently reduced.

Whether looked at analytically or empirically, consequently, the probability that there will be no reduction in Sea-Tac activity levels whether or not the Third Runway, and related facilities, are built is so low that it cannot be taken seriously.

4.10 - SEA-TAC'S LIKELY CAPACITY LIMITS

Airport capacity and airport delay are closely related concepts. As discussed by the FAA in Advisory Circular 150/5060-5 (23 September 1983), *Airport Capacity and Delay*:

> *"As demand approaches capacity, individual aircraft delay is increased. Successive hourly demands exceeding the hourly capacity result in unacceptable delays. When the hourly demand is less than the hourly capacity, aircraft delays will still occur if the demand within a portion of the time interval exceeds the capacity during that interval. Because the magnitude and scheduling of user demand is relatively unconstrained, reductions in aircraft delay can best be achieved through airport improvements which increase capacity."*

The concept of Airport Capacity is usually defined in technical literature to be the maximum number of aircraft operations that can be accommodated at an airport in an hour.

An airport's Annual Service Volume (ASV) is an estimate of the number of operations the airport can accommodate in a year. At any airport, the ASV is a function of the runway-use configuration, percent arrivals, percent touch-and-go's, taxiways, airspace limitations, runway instrumentation, and weather conditions. Most of the analyses referred to earlier in this chapter use standard, FAA recommended modeling procedures to estimate Sea-Tac's ASV at approximately 380,000 operations.

Annual operation levels will be effected by year-to-year weather fluctuation, changes in air traffic control (ATC) procedures that affect airspace limitations, and other factors. As the ASV level after which airport improvements are required if future demand levels are to be accommodated, 380,000 operations is Sea-Tac's consensus threshold. As shown in Table 4.05, Sea-Tac is forecast to reach 379,200 operations in the Year 2000, effectively bumping up against its threshold ASV of 380,000 operations.

As shown in Table 4.05, Sea-Tac is forecast to increase aircraft operations by 62,400 (16.5%) after the Year 2000. Passenger enplanements are forecast to increase by 7,700,000 (67.5%) after the Year 2000. Cargo movements are forecast to increase by 370.0 metric tons (72.5%) after the Year 2000. These increases occur after Sea-Tac reaches its current ASV, and they occur because the Airport accommodates its forecasted demand levels by building the Third Runway, and related airport improvements. These activity levels will not occur at Sea-Tac without construction of the Third Runway, and related improvements. The consequences of the growth of operations, enplanements and cargo movements after Sea-Tac reaches its threshold ASV of 380,000 in the Year 2020, are the socio-economic impacts that require mitigation.

Table 4.05
Forecast of Operations, Enplanements and Cargo

Operation	1993 (actual)	2000	2010	2020
Aircraft Operations	**339,500**	**379,200**	**405,800**	**441,600**
Change in Aircraft Operations	---	+39,700	+26,600	+35,800
Cumulative Change	---	+39,700	+66,300	+102,100
Cumulative Change after 2000	---	---	+26,600	+62,400
Enplaned Passengers	**9,400,000**	**11,400,000**	**15,300,000**	**19,100,000**
Change in Enplaned Passengers	---	+2,000,000	+3,900,000	+3,800,000
Cumulative Change	---	+2,000,000	+5,900,000	+9,700,000
Cumulative Change after 2000	---	---	+3,900,000	+7,700,000
Air Cargo Tons (metric tons)	**381,000**	**510,000**	**680,000**	**880,000**
Change in Air Cargo Tons	---	+129,000	+170,000	+200,000
Cumulative Change	---	+129,000	+299,000	+499,000
Cumulative Change after 2000	---	---	+170,000	+370,000

(Source: P&D Aviation, 20 August 1994, Tables 5-8, 5-11 and 5-15)

SECTION 5

AIRPORT MITIGATION CASE STUDIES

SECTION 5
AIRPORT MITIGATION CASE STUDIES

5.01 - AIRPORTS WITHIN THE UNITED STATES

Airports across the United States have found it necessary to reduce or mitigate the impacts of their aircraft operations on surrounding residents and businesses. Airport mitigation is generally accomplished under the requirements of Federal Aviation Regulations (FAR) Advisory Circular Part 150 (commonly referred to as Part 150).

In order to determine the type of mitigation measures typically used, the mitigation programs of six US airports were analyzed studied. These airports were selected because of similarities with Sea-Tac International Airport's proposed project or as examples of the most recent mitigation programs. These selected case studies represent airports of varying size, location, and operations. All airports contacted had developed (or were developing) mitigation and remediation programs as a result of airport expansion projects. Telephone and in-person interviews were conducted with representatives of the following airports:

- **Colorado Springs International Airport (Colorado Springs, Colorado)** - Colorado Springs has experienced rapid recent growth as a result of the new Denver International Airport (DIA). Some of this growth at Colorado Springs has been attributed to higher landing fees at DIA. Also, it is now a longer trip to DIA (north of Denver) than it was to Denver's former international airport (Stapleton), so the Colorado Springs airport (south of Denver) has become more "geographically attractive". At the time of the telephone interview, Colorado Springs was in the process of developing a mitigation plan in support of a new runway project to meet this increasing demand.

- **Dallas/Fort Worth International Airport (Dallas, Texas)** - One of the largest and busiest airports in the world, DFW began operation in 1974. The land occupied by DFW is located between the cities of Dallas and Fort Worth. At the time DFW was initially designed, it was presumed that this site would be large enough to contain the ultimate airport build-out plan and all the accompanying impacts. As DFW continued to grow over the years, so too did the area surrounding the airport property. Today, DFW is surrounded by development. In the late 1980s, DFW began the process of developing a plan to add two new runways. Due to the amount of surrounding development, DFW had to develop a mitigation program for its four neighboring communities.

- **Lambert Field/St. Louis International Airport (St. Louis, Missouri)** - Lambert Field is an older urban airport which serves the St. Louis metropolitan area. It has an on-going mitigation and remediation program for its established neighboring communities, including Bridgeton (a low-income community).

- **Minneapolis/St. Paul International Airport (Minneapolis, Minnesota)** - Rather than build a new airport away from the city, the Minneapolis/St. Paul Airport is planning for the expansion of its existing facility. The Airport is located between the two cities (southeast of Minneapolis) and is surrounded by established communities, such as Richfield and Bloomington.

- **San Diego International Airport (San Diego, California)** - San Diego Airport is located in downtown San Diego along the shoreline of San Diego Bay. At 474 acres and with a single runway, it is the smallest airport that was studied. The area surrounding the airport is mostly non-residential and the arrival and departure paths bring aircraft at low altitudes over downtown and some residential areas. The cost of real estate and the expansion of the San Diego metropolitan area make siting a new airport impractical. According to Airport staff, the best option is to acquire approximately 500 acres adjacent to the Airport which is currently owned by the US Navy.

- **San Francisco International Airport (San Francisco, California)** - San Francisco Airport is an older facility, but it is located in San Francisco County and adjacent to San Francisco Bay. Consequently, much of the arrivals and departures are made over water. The area surrounding the Airport has developed with mostly industrial uses, with some residential areas located to the north and west. Because of the expense associated with a new airport and due to the fact that land in the San Francisco area is not available, improvements are being made to the existing facility.

Table 5.01 summarizes the general information on the airports studied.

Table 5.01
General Information on Case Study Airports

Information	Airport					
	Colorado Springs	**Dallas/ Fort Worth**	**San Diego**	**Saint Louis**	**Minneapolis/ St. Paul**	**San Francisco**
Size	7,200 acres	18,000 acres	474 acres	2,100 acres	3,100 acres	(a)
Annual Enplanements	2,500,000	57,000,000	13,000,000	(a)	27,000,000	(a)
Annual Operations	54,750	876,000	230,000	(a)	465,000	300,000
Airport Administered By	City of Colorado Springs	Dallas/ Fort Worth Airport Board	San Diego Unified Port District	City of St. Louis	Minnesota Airport Commission	Consolidated City/County of San Francisco
Cost of Mitigation Program	(a)	$150 million	$11 million (schools) $15 million (Phase 1)	(a)	(a)	(a)

(a) Information not available at time of survey

(Source: 1996 Airport Case Study Survey)

5.02 - AIRPORT/AIRCRAFT NOISE

Noise is the most common impact that is mitigated by US airports. However, how the noise impacts are measured and assessed are at the heart of an ongoing debate between airports and airport communities. Noise is typically generated by the following airport activities::

- By aircraft on either arrival or departure (departures are much louder than arrivals).
- By aircraft on the ground when backing away from the gate under their own power ("power-backs").
- By aircraft on the ground when performing engine maintenance tests which require powering up the engines to almost full thrust ("maintenance run-ups").

Noise is considered to be both an aviation and an environmental impact, so both the FAA and the United States Environmental Protection Agency (USEPA) define the means by which noise is measured. The standard noise descriptor mandated by these Federal agencies is the Day-Night Average Sound Level (LDN).

LDN provides a numerical description of the weighted 24-hour cumulative noise energy level using the A-weighted decibel scale over one year, with nighttime aircraft operations being weighted heavier than daytime operations. The LDN formula weighs aircraft operations during "daytime" operations (7:00 AM to 7:00 PM) at a 1-to-1 ratio. "Nighttime" operations (7:00 PM to 7:00 AM) are weighted at a 10-to-1 ratio.

Because LDN is often referred to as an "average" noise level, it is not an accurate representation of individual noise events for a specific location. This is the core of an ongoing debate between airport-area communities and airports regarding this method of noise measurement. Airport-area communities feel that Single-Event Noise Levels (SELs) are the more accurate representation of noise associated with airports. As of January 1997, neither FAA nor USEPA recognize SELs as the accepted means to measure airport noise.

Aircraft are classified by "stages" which has a direct correlation to their noise output:

- Old Stage 1 aircraft are no longer allowed to operate in the United States.
- Operation of Stage 2 aircraft will be prohibited in the United States by the Year 2000.
- Stage 3 aircraft will be allowed to operate in the United States beyond the Year 2000. Stage 2 aircraft that have been retrofitted with new engines - "hush kits" - which meet Stage 3 standards also will be allowed to operate.
- Establishment of a new Stage 4 standard is being considered, but it is anticipated that it will result in a minimal additional noise reduction (approximately 3 dBA).

US airports rely on FAR Part 150 to define how noise will be measured and mitigated. Part 150 is also the basis for FAA funding for noise mitigation programs. Airports that exceed the Part 150 requirements may be eligible for additional FAA funding (on a case-by-case basis) or may fund the mitigation programs from other sources.

5.03 - NOISE MITIGATION - PURCHASE/RELOCATION

Residential, business, school, church, and other properties that are identified to be within excessive noise areas are purchased outright by the airport. Residents and businesses are also eligible for relocation payments under the Uniform Relocation Assistance Act (US Department of Transportation, 49 CFR, Part 24). In these cases, the purchased area usually becomes part of the airport property and is restricted from future development/redevelopment.

A variation on the purchase/relocation program is some form of sales assistance. The airport will either act as a broker or as a third-party agent to foster the sale of a property where the airport will not take title. Assistance programs that maintain residential neighborhoods do not remove the area's incompatibility potential. In some cases, assistance programs can be used to assemble land to replat and redevelop former residential areas as airport-oriented non-residential uses.

DFW International Airport has developed the most comprehensive airport purchase program. Not only are homes within the 65 LDN contour purchased, but the purchase area is extended to encompass entire neighborhood areas, sometimes extending as far as the 62 LDN contour.

St. Louis has only purchased homes to the 70 LDN contour. The Minneapolis/St. Paul program is currently being developed, but will also likely purchase only to the 70 LDN contour.

The least comprehensive program is in San Francisco, where no homes are purchased. Residential areas are subjected to 70 and 75 LDN contours. Similarly, the areas surrounding San Diego's airport are non-residential and are not offered mitigation.

At the time of this report, Colorado Springs was evaluating the need for off-site noise mitigation, but no information was available from the airport.

5.04 - NOISE MITIGATION - SOUND INSULATION

Residential, business, school, church, and other properties that are identified - by the airport's interpretation - to be within noise areas that are not excessive enough to warrant purchase, are usually offered sound insulation programs.

These vary from airport to airport, but generally involve added attic insulation, triple-paned windows, and in some cases, central air conditioning. Sound insulation, however, does not adequately address mitigation of outdoor activities associated with homes, schools and parks.

In some cases, sound insulation of older, deteriorating homes can exceed that structure's value. When air conditioning is added, some residents, businesses, schools, or churches cannot afford the additional electric utility costs associated with keeping the system running.

Sound insulation is offered by all airports studied, but with variations in each program. For instance, DFW offered sound insulation to homes outside the 65 LDN "neighborhood" contour, in concert with an avigation easement (as discussed in Section 5.05).

St. Louis offers sound insulation as an option for homeowners in the 65 to 70 LDN contour (the other options being sales assistance or an avigation easement). In the poorer neighborhoods that surround St. Louis airport, the value of sound insulation exceeds the value of the structure. The airport considers sound insulation to be adequate compensation for the homeowner in these cases. San Francisco and Minneapolis have similar insulation programs for homes, businesses, schools and churches.

Title 21 of the California Noise Standards requires areas 65 CNEL and higher to be mitigated. CNEL (Community Noise Equivalent Levels) contours are very similar to LDN contours, except in the way aircraft operations are weighted (the LDN weighting approach described previously). The CNEL approach weighs operations in the following manner:

- 7:00 AM to 7:00 PM - 1-to-1 ratio.
- 7:00 PM to 10:00 PM - 3-to-1 ratio.
- 10:00 PM to 7:00 AM - 10-to-1 ratio.

The area surrounding San Diego's airport is mostly non-residential, but the airport has identified upwards of 750 homes that may require sound insulation under a Phase 1 mitigation program (still being developed). The airport has also almost completed an $11 million sound insulation of 6 schools.

Minneapolis offered sound insulation to area schools, but also required that the facilities stay in service for a specific period of time (20 years), so that improvements would not be made to an obsolete facility.

5.05 - NOISE MITIGATION - AVIGATION EASEMENTS

Residential, business, school, church, and other properties that are identified - by the airport's interpretation - to be impacted by aircraft activity also may be offered an "avigation easement". This instrument is similar to other property easements, except that it is permits passage through a property's air space, not on the ground like a utility easement.

Avigation easements are usually offered to property owners in exchange for a one-time payment and become a permanent attachment to the property deed. Payment may be a portion of the value of the property (sometimes as high as 25%) or may be offered in combination with a sound insulation program.

DFW once again had the most comprehensive avigation easement program. Easements were offered to homeowners in the 60 LDN contour at 25% of the fair market value of the home. However, DFW also learned that homeowners perceived the 25% payment as a beginning point for negotiation. Many turned down the easement in the hopes that a higher price would be offered (which was not).

DFW also acknowledged that the 25% payment was approximately equal to the reduction in property value as a result of aircraft activity. In theory, the avigation easement would give the owner of a $100,000 home a one-time cash payment of $25,000. The homeowner could then sell his/her home for as low as $75,000 and walk away from the transaction with no financial impact. The buyer would get a $100,000 home for a reasonable price and would be aware of the avigation easement at the time of purchase.

In other airports, the avigation easement was a requirement of accepting the sound insulation improvements. No cash payment was offered for the easement.

5.06 - PERMANENT NOISE MONITORING

All the airports studied had some form of permanent noise monitoring program in place. San Francisco conducts quarterly noise monitoring tests, while others monitor it continuously. The number and location of the monitors varies with each airport. St. Louis, for instance, has 13 permanent and 10 temporary noise monitoring stations. Minneapolis has 24 permanent noise monitoring stations and integrates the data with their geographic information system (GIS) data. San Diego has been providing permanent noise monitoring since 1974, and now has 24 permanent monitoring stations, also integrated with their GIS system.

5.07 - TRAFFIC/TRANSPORTATION MITIGATION

When an airport's capacity is enhanced, the number of enplanements and operations also increases. This has an associated increase in ground traffic headed to and from the airport. Most airports contacted do not offer any mitigation for off-site access and circulation. The exceptions were DFW and San Diego.

DFW has been working with the Texas Department of Transportation to construct and east/west connector highway which links two regional freeways (SH 161 and SH 360) with the airport's south entrance. San Diego will be building a new $28 million access roadway to improve airport access, but the new roadway will still connect with surface streets, rather than regional freeways.

5.08 - CONSTRUCTION MITIGATION

Except for the mitigation required as part of obtaining various permit approvals,. none of the airports contacted offered a mitigation program during project construction,. DFW was able to utilize dirt removed for construction of an adjacent freeway (SH 161) to build the new east runway. The remaining construction spoils were contained totally on-site. Given DFW's size (18,000 acres), construction traffic and staging was contained totally within airport property. DFW is also accessible from several major regional freeways, so there was no traffic impacts on the few local streets adjacent to the airport.

San Francisco, too, relies on regional freeways for its primary airport access. While these freeways are also heavily traveled by non-airport traffic, there is no capacity-enhancing project currently underway at the airport.

Minneapolis representatives stated that they had not yet assessed the potential construction impacts. They projected that most impacts would be traffic related (construction vehicles) and that the system of regional freeways accessing the airport would be satisfactory to handle the increase in traffic.

5.09 - COMMUNITY MITIGATION

Of the airports contacted, none offered any mitigation measures to reduce the impact on neighboring community facilities and services. Beyond sound insulation of structures, no measures were developed to mitigate impacts to parks, public safety services, the tax base, or other community facilities and services.

Absence of these measures, however, does not diminish their need. The St. Louis airport does have close-in residential and is experiencing compatibility problems which are yet to be resolved. (The other airports studied are not located in as urbanized a setting as Sea-Tac is. Airports in Colorado Springs, Dallas/Fort Worth, and San Franscisco are located away from population centers. San Diego's airport, while close to downtown, is surrounded by industrial and non-residential uses.)

5.10 - NOISE ABATEMENT PROCEDURES

All of the airports contacted have in place some formal noise abatement program which regulates the operation of aircraft on the ground and aloft during certain hours. Airports near lakes, bays, or other bodies of water commonly require a "water approach" for arrivals and departures.

Others restrict the use of Stage 2 aircraft during certain hours, or require those aircraft to follow arrival/departure corridors which fly over non-residential areas. The most restrictive nighttime procedures are at San Diego, which prohibits all departures, except for emergencies, between the hours of 11:30 PM and 6:30 AM. This includes cargo and passenger service.

5.11 - MAINTENANCE RUN-UPS

It is common to restrict or prohibit maintenance run-ups in the evening and early morning hours. St. Louis allows no more than a 2-minute run-up at 90% power. San Francisco minimizes, but does not prohibit run-ups. Minneapolis restricts aircraft operations between 11:00 PM and 6:00 AM to Stage 3 aircraft whenever possible, and prohibits maintenance run-up during these hours. San Diego will be phasing out Stage 2 aircraft by 1999 (one year earlier than required) and prohibits maintenance run-ups between the hours of 11:30 PM and 6:30 AM, with a restriction on departures also during that time.

5.12 - POWER BACKS

The way aircraft back away from the gate also can create noise. Aircraft can either back away from the gate under their own power - called "power backs" - or be pushed back using an airplane tug ("push backs"). Most airports now use push backs as a standard procedure. St. Louis even designed their aprons to slope slightly away from the gate to facilitate push backs.

San Diego and Minneapolis have no formal policy on power backs, but both say that push backs are more common.

5.13 - CASE STUDY SUMMARY

The airports contacted represent a cross-section of American airports in urbanized and urbanizing areas. They appear to "go by the book" when it comes to FAA-funded mitigation. Mitigation and remediation programs seem to be confined to noise abatement - through property acquisition, sales assistance, sound attenuation/insulation, avigation easements, and airport abatement procedures.

Most neighboring communities feel that the airports do not do enough to adequately compensate them for the "privilege" of having the airport as their neighbor. They routinely cite the inadequacy of LDN as a true measurement of noise impact, and promote the use of SEL contours instead.

Airport communities also have to live with reductions in the tax base, diminishing residential property values, increased traffic, and other community impacts, without any compensation or assistance from airports, the states, the FAA, the USEPA, or any other agency.

In summary, aside from noise, no other impacts were routinely mitigated at the case study airports.

SECTION 6

WASHINGTON STATE MITIGATION CASE STUDIES

SECTION 6
WASHINGTON STATE MITIGATION CASE STUDIES

6.01 - WASHINGTON STATE EXPERIENCE

The State of Washington has demonstrated its desire to go beyond "traditional" mitigation measures as defined by Federally-funded programs. Several members of the consulting team, as well as staff from the City of Burien, have been involved in some of these projects.

For the purposes of comparison, the following case studies have been summarized:

- Puyallup Indian Tribe Land Claim
- Boeing/Everett Facility Expansion
- Satsop Power Plant Site Mitigation Plan
- IH-90 Freeway Improvement Project

Each case study exhibits mitigation that exceeds traditional physical remediation to include socio-economic and cultural mitigation.

6.02 - PUYALLUP INDIAN TRIBE LAND CLAIM

The Federal Government, the State of Washington, and various Pierce County local governments reached an agreement with the Puyallup Indian Tribe in August 1988 to relinquish tribal claims to land, tidelands, mineral claims, submerged lands, non-fisheries, and water rights. In return, the Tribe received 899 acres of land valued at $37.46 million, given on an "on-reservation" status.

The Tribe was also paid $24 million which was placed in an annuity fund. Each enrolled Tribe member 21 years old and older received a $20,000 cash payment. For remaining Tribe members under 21, a similar cash payment will be made upon their twenty-first birthday (by August 2009). Mitigation measures also included a $22 million trust fund to be used for housing, education and cultural preservation, supplemental health care, elderly care and day care centers, substance abuse, burial and cemetery maintenance. This trust fund would exist in perpetuity along with the Tribe.

The State and the Port of Tacoma jointly agreed to fund a $9.235 million fisheries enhancement program. The mitigation agreement required that the Tribe agree to specific projects to reduce conflicts between tribal fishing and commercial shipping. Job training was offered to 265 Tribe members, with 115 jobs offered in the private sector (valued at $2.5 million).

The agreement also granted $9.5 million to the Tribe for economic development of existing tribal lands, $2.0 million in business development funds for enterprises by Tribe members, and $2.5 million (the latter to be paid over a 20-year period) for the Tribe's participation in the Blair waterway project (widening and deepening of the channel to open it to foreign trade). In exchange, the Tribe agreed not to assert their taxation power for "non-trust" lands and to not exercise their authority over these lands and over "non-Indians" to protect the fisheries.

6.03 - BOEING/EVERETT FACILITY EXPANSION

This agreement involved the City of Everett, Washington and the Boeing Company which allows Boeing to expand their airplane manufacturing facility. The agreement was reached in September 1991, pursuant to the Washington State Environmental Protection Agency (SEPA) review and approval of the project.

The agreement lists specific Federal, State, and local requirements which Boeing must meet in order to mitigate identified impacts, including air, earth, surface water, plants, animals, wetlands, hazardous materials, and transportation. The Boeing expansion project would be denied if these conditions are not met. The agreement identified both on-site and off-site mitigation requirements.

On-site, Boeing must submit a revised site plan to the City of Everett which reflects the SEPA "decision document" and specifies construction requirements. Boeing must manage on-site environmentally-sensitive areas, landscaping, surface water, and transportation. The expansion project site was divided into five areas, with specific impacts and mitigation measures identified for each area.

Off-site, Boeing would provide $46.1 million for transportation mitigation, including purchasing 10 buses and 80 vans for ride-sharing purposes, and funding transportation system improvements and demand management strategies. Boeing would also fund a program ($3.9 million) to address company-related traffic through residential neighborhoods.

The project EIS projected that the expanded facility would attract 54,000 new workers to the area. Boeing agreed to invest $2.0 million in the "Local Initiative Support Coalition", seek new employees from the local impact area, and coordinate with local community colleges to develop vocational training in skills areas needed by Boeing. Boeing would also fund the necessary additions to the City's public safety personnel. At 1.9 firefighters and 1.4 security officers per 1,000 employees, that resulted in 102 new firefighters and 76 new security officers.

6.04 - SATSOP POWER PLANT SITE MITIGATION PLAN

This agreement involved the Washington Public Power Supply System (WPPSS) and the Washington State Department of Wildlife. involving proposed additions to the nuclear power plants operated by WPPSS. In return for project approval, WPPSS would replace and/or compensate for any fish and wildlife damage or loss resulting from the project. WPPSS also agreed to the State's measures to protect wildlife.

The agreement first required a habitat evaluation preservation analysis of the Satsop site, which determined the need for mitigation. The agreement ensured compliance, along with a site certification process.

Different areas on or near the construction site were identified which would require mitigation. In some cases, mitigation only consisted of preservation of the existing habitat. In other areas, mitigation involved limits to vehicular access, limits to thinning and tree removal, eliminating root rot, enhancing brush areas, maintenance of foraging fields, and preservation of ponds. The agreement also identified preservation zones in which no land management or wildlife enhancement activities would be conducted.

6.05 - IH-90 FREEWAY IMPROVEMENT PROJECT

An agreement between the Washington State Highway Commission ("Commission"), Metro, King County, and the cities of Seattle, Mercer Island and Bellevue was reached regarding proposed IH-90 improvements (between IH-405 and IH-5).

The Commission's design for IH-90 would incorporate all of the provisions for community amenities and for the reduction of adverse environmental impacts. The Commission agreed to participate with the City of Seattle in a planning study which addressed redevelopment of areas adjacent to the project. Additionally, the Commission would transfer fee title of all State-purchased lands (outside the project right-of-way) to the local jurisdictions at the lowest cost possible. IH-90 would be operated in a manner that encourages growth and development in King County's urban areas, but not in undeveloped areas. A review team was established to monitor the project and advise the Commission on the development of IH-90. The Commission would also become responsible for the design and construction of the portion of IH-90 that can be funded with Federal interstate funds, as well as the other parties responsible for the design and construction of the remaining facilities.

This agreement ended more than 20 years of dispute between the local cities and the Commission.

SECTION 7

POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION

SECTION 7
POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION

7.01 - INTRODUCTION

In evaluating the potential environmental impacts of the proposed Third Runway project, measures that were utilized in other airport and/or public facility projects have been employed for the five impacted communities being studied. The following impact measures were utilized in this study and are discussed in more detail below:

- **Noise and Vibration**
  - LDN (average day/night noise level)
  - SEL (single-event noise level)
  - Threshold analysis
  - Vibration

- **Air Quality**
  - Air emissions (aircraft)
  - Carbon monoxide air emissions (vehicles)
  - Hydrocarbon air emissions (vehicles)
  - Air toxics
  - Fugitive emissions (dust)
  - Point sources

- **Surface Water Quality and Hydrology**
  - Runoff volume
  - Erosion and sediment
  - Spills

- **Ground Water Quality and Hydrology**
  - Aquifer recharge
  - Contamination

- **Wetlands**
  - Wetland destruction

- **Floodplains**
  - Encroachment
  - Reduced flood storage capacity
  - Increased flow rates and volumes

- **Aesthetics and Visual**
  - Ground shadow
  - Visibility of aircraft
  - Visibility of fill

- **Other Environmental Mitigation**
  - Special status species and habitats
  - Cultural resources
  - Coastal zones
  - DOT Section 4(f) resources

Table 7.01
EIS Chapters Reviewed for Environmental Issues Mitigation Measures

Chapter	Section	Title
--	--	Executive Summary
III	--	Affected Environment
IV	2	Land Use
IV	7	Human Health
IV	9	Air Quality
IV	10	Water Quality and Hydrology
IV	11	Wetlands
IV	12	Floodplains
IV	19	Earth
IV	20	Solid Waste
IV	21	Hazardous Substances
IV	23	Construction Impacts
IV	24	Aesthetics and Urban Design
V	--	Probable, Unavoidable, Adverse Environmental Impacts and Mitigation Measures
Appendix C	--	Noise Impacts
Appendix D	--	Air Pollutant Methodology
Appendix N	--	Aesthetic Views and Photos
Appendix P	--	Natural Resource Mitigation Plan
Appendix Q	--	Water Studies
Appendix Q-A	--	Baseline Groundwater Study
Appendix Q-B	--	Preliminary Water Conservation Plan
Appendix Q-C	--	Concepts for Using a Constructed Aquifer to Manage Airport Stormwater
Appendix R	--	Responses to Public Comments

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996)

The discussion of mitigation measures for the environmental issues includes construction and operation (post-construction) of the facilities associated with Master Plan Update implementation. The discussion follows the same format of the topics discussed in the Environmental Issues evaluation. Although some topics may not be impacted by construction or operation of the proposed facilities.

The mitigation measures evaluation includes some discussion of the proposed mitigation measures in the Final EIS for the Sea-Tac International Airport Master Plan Update. These mitigation measures were discussed in the EIS Chapters shown in Table 7.01.

7.02 - NOISE AND VIBRATION - LDN MITIGATION

As part of the EIS, aircraft noise effects were evaluated for the existing conditions. Master Plan Update implementation during construction will not impact aircraft noise levels which are a part of Airport operations. However, there may be an interaction between aircraft noise and construction activities. This area of concern was not addressed in the EIS. Therefore, as part of the mitigation measures for noise, this evaluation should be conducted by the Port of Seattle to determine potential impacts on the areas to the northwest, west and the southwest of the Airport during construction. This evaluation should be done using an appropriate computer model, taking into consideration the models that were used in the EIS.

Average noise contours (LDN) are computer-generated by a software program (the Integrated Noise Model) to represent the impact of air traffic at various years and/or service levels. Figure 7.01 shows the projected noise contours for the Airport's "preferred alternative" in the Year 2020 as included in the Airport's EIS.

Previous research by FAA has determined that exposure to certain noise contours is incompatible with certain types of land uses. Recent airport noise mitigation programs - such as the program in place at Dallas/Fort Worth International Airport developed by Landrum & Brown, Inc. - have shown the importance of mitigating entire residential neighborhoods, rather than individual structures. In the Dallas/Fort Worth program, entire neighborhoods were mitigated which fell within the 65 LDN contour. This resulted in mitigation of individual structures which were below the projected 65 LDN contour line.

Two types of mitigation measures were projected to address LDN noise impacts.

Acquisition and Redevelopment

For the area surrounding Sea-Tac International Airport, neighborhoods which were impacted by the Airport's projected 65 LDN contour were considered to be exposed to excessive noise impacts which result in the reduction of property values, quality of life, and stability of the neighborhood.

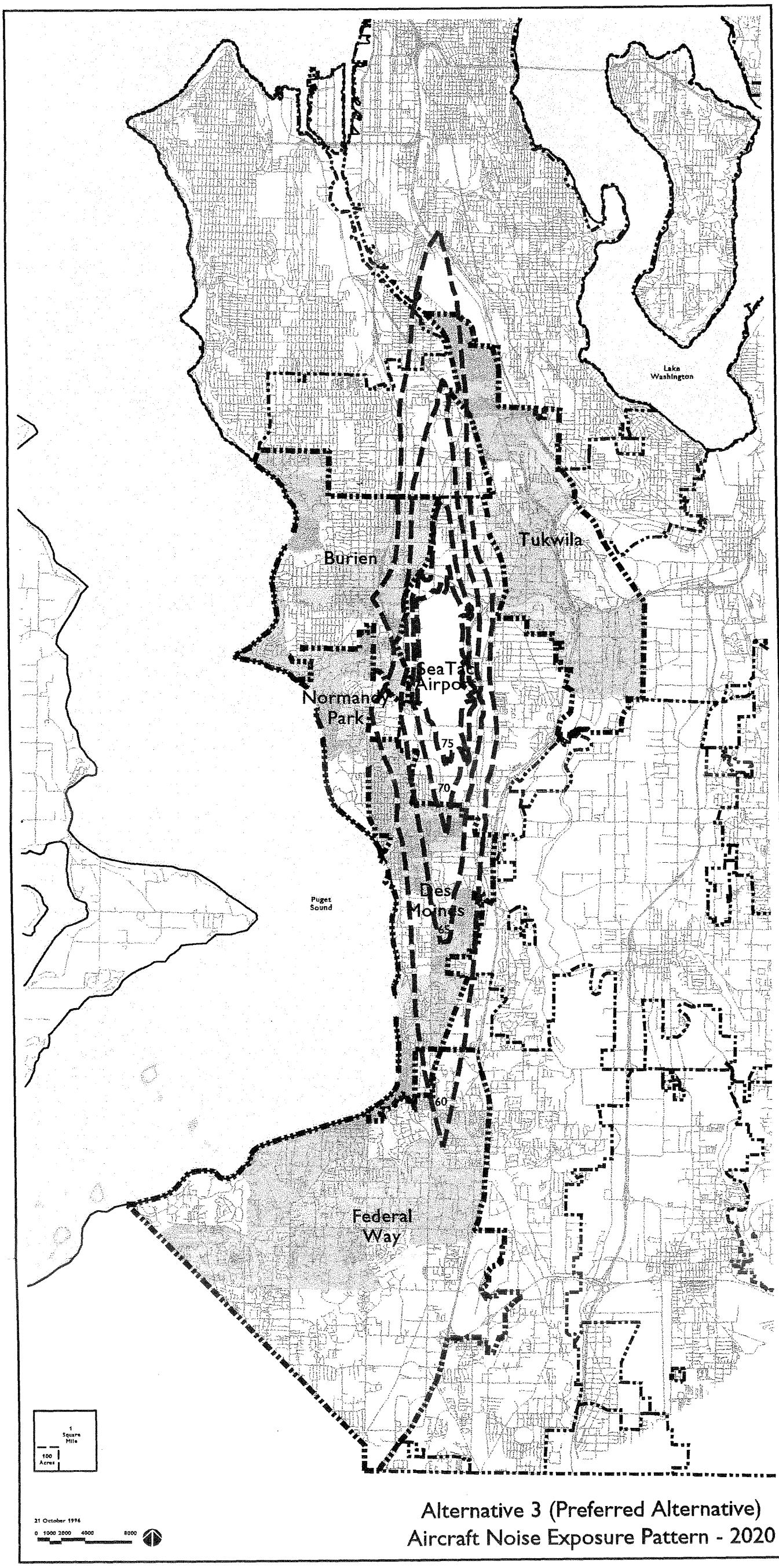
(A neighborhood which was one-third or more within the 65 LDN contour was considered to be impacted.) In those cases, this study recommends that these neighborhoods be considered candidates for redevelopment as non-residential uses. Costs involved with acquiring and redeveloping a neighborhood will involve residential and business acquisition and relocation costs in accordance with the Uniform Relocation Assistance Act (US DOT, 49 CFR, Part 24). Also included is the removal of structures, improvement of the utility infrastructure, and packaging and marketing the land for redevelopment. It is estimated that these costs will average $760,000 per acre, exclusive of additional on-site improvements.

Table 7.02 details the neighborhoods, Highline schools, and Highline Community Hospital facilities that have been identified as candidates for acquisition and redevelopment.

Table 7.02
Neighborhoods Identified for Acquisition and Redevelopment

City	Area	Amount
Burien	**Neighborhoods (1)**	
	Northeast neighborhood	$537.0 million
	Schools (3)	
	Cedarhurst Elementary School	$ to be determined
	Sunnydale Elementary School	$ to be determined
	Marine Tech Lab School	$ to be determined
Des Moines	**Neighborhoods (4)**	
	West Central neighborhood	$364.0 million
	North Central neighborhood	$183.2 million
	East Central neighborhood	$475.8 million
	South Des Moines neighborhood	$373.9 million
	Subtotal - Neighborhoods	**$1,396.9 million**
	Schools (3)	
	Midway Elementary School	$ to be determined
	Pacific Middle School	$ to be determined
	Mount Rainier High School	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for acquisition and redevelopment.	
Normandy Park	No neighborhoods in Normandy Park have been identified for acquisition and redevelopment.	
Tukwila	No neighborhoods in Tukwila have been identified for acquisition and redevelopment.	
Other Highline School District Schools	**City of Seattle**	
	Southern Heights Elementary School	$ to be determined
	Unincorporated King County	
	Beverly Park Elementary School	$ to be determined
	Satellite Alternate High School	$ to be determined
Total Study Area		**$1,933.9 million (plus costs to be determined)**

Figure 7.01
LDN Noise Contours



While acquisition and redevelopment is the most far-reaching mitigation measure, this study acknowledges that it is also the most invasive of the mitigation measures studied. While it fully addresses land use incompatibility, it also has several serious repercussions:

- Acquisition and redevelopment removes existing neighborhoods and tax base.
- Viable redevelopment of acquisition areas may take several years.
- Acquisition and redevelopment is the most costly mitigation measure. A detailed land use inventory of each neighborhood need to be completed in order to develop more focused cost-estimates and projections.
- Acquisition and redevelopment is not in accordance with each City's comprehensive plan. Plans will have to be modified and revised if this mitigation measure is pursued.
- Acquisition and redevelopment as described above is based upon neighborhood boundaries identified by City representatives. Further study is required to determine if these are the most acceptable boundaries, or if "sub-neighborhoods" can be identified to minimize the need for complete redevelopment as shown.

It is recommended that the neighborhoods and schools identified in Table 7.02 be considered as "potential candidates" for acquisition and redevelopment. However, before any acquisition or redevelopment is initiated, a study should be conducted to further consider each neighborhood and school to determine if there are other less disruptive alternatives to acquisition and redevelopment. This study should be completed prior to construction of the Third Runway.

Sound Insulation and Avigation Easements

Neighborhoods where one-third or more of the area falls within the 60 to 65 LDN contour are subject to noise impacts that impact residents' ability to fully enjoy their properties, but does not threaten the stability of the neighborhood.

In these cases, this study recommends that these neighborhoods be considered candidates for sound abatement insulation and avigation easements. Costs will include attic and wall insulation, triple-glazed window systems, and air conditioning for older structures.

Avigation easements should be a function of property value. For example, Dallas/Fort Worth International Airport has offered avigation easements in the amount of 25% of the property value (value is figured as a comparable value unaffected by an airport).

It is estimated that these costs will average $37,500 per acre, and should vary according to density and age of development.

Table 7.03 details the neighborhoods, Highline schools, and Highline Community Hospital facilities that have been identified as candidates for acquisition and redevelopment.

Table 7.03
Neighborhoods Identified for LDN
Sound Insulation and Avigation Easements

City	Area	Amount
Burien	**Neighborhoods (4)**	
	East Central neighborhood	$23.4 million
	Southeast neighborhood	$10.0 million
	Gregory Heights neighborhood	$21.5 million
	Downtown neighborhood	$12.0 million
	Subtotal - Neighborhoods	**$66.9 million**
	Schools (7)	
	Gregory Heights Elementary School	$ to be determined
	Hazel Valley Elementary School	$ to be determined
	Salmon Creek Elementary School	$ to be determined
	Seahurst Elementary School	$ to be determined
	Shorewood Elementary School	$ to be determined
	Sylvester Middle School	$ to be determined
	Highline High School	$ to be determined
	Hospitals (1)	
	Highline Community Hospital	$ to be determined
Des Moines	**Neighborhoods (4)**	
	North Hill neighborhood	$23.4 million
	Zenith neighborhood	$20.6 million
	West Woodmont neighborhood	$16.1 million
	East Woodmont neighborhood	$11.5 million
	Subtotal - Neighborhoods	**$71.6 million**
	Schools (4)	
	Des Moines Elementary School	$ to be determined
	North Hill Elementary School	$ to be determined
	Olympic Elementary School	$ to be determined
	Parkside Elementary School	$ to be determined
Federal Way	**Neighborhoods (2)**	
	Star Lake neighborhood	$19.5 million
	Wildwood neighborhood	$20.7 million
	Subtotal - Neighborhoods	**$40.2 million**
Normandy Park	**Neighborhoods (1)**	
	East Central neighborhood	$3.4 million
	Schools (1)	
	Marvista Elementary School	$ to be determined
Tukwila	**Neighborhoods (1)**	
	M.I.C. neighborhood	$40.6 million

Table 7.03 (continued)

City	Area	Amount
Other	**City of SeaTac (7)**	
Highline School	Bow Lake Elementary School	$ to be determined
District Schools	Madrona Elementary School	$ to be determined
	McMicken Heights Elementary School	$ to be determined
	Valley View Elementary School	$ to be determined
	Chinook Middle School	$ to be determined
	Tyee High School	$ to be determined
	SeaTac Occupational Skills School	$ to be determined
	City of Seattle (5)	
	Hilltop Elementary School	$ to be determined
	Mount View Elementary School	$ to be determined
	Riverton Heights Elementary School	$ to be determined
	Cascade Middle School	$ to be determined
	Evergreen High School	$ to be determined
	Unincorporated King County (1)	
	White Center Heights Elem. School	$ to be determined
Total Study Area		**$222.7 million (plus costs to be determined)**

While insulation and avigation easements are less disruptive than acquisition and redevelopment, there is still the potential to change the character of the neighborhood.

It is recommended that the neighborhoods and schools identified in Table 7.03 be further studied to determine the full extent of the proposed insulation and easement program. This study should be completed prior to construction of the Third Runway.

7.03 - NOISE AND VIBRATION - SEL MITIGATION

Single-event noise levels (SEL's) are those associated with an individual aircraft, either on the ground or aloft. Airport neighbors across the country argue that this is a more appropriate measure of noise impact. Airports, the FAA, and USEPA counter with the fact that LDN is the only acceptable measure of noise. Rather than attempt to resolve this philosophical disagreement, this study will identify areas that are subject to SEL impacts and recommend mitigation measures that may or may not be implemented. In the Sea-Tac area, neighborhoods that are within the 400-foot topographic line and within 5 miles of the Airport are likely to experience SEL noise associated with ground and flight operations.

For these areas, the same sound abatement insulation and avigation easement program would be an appropriate response. In some cases, these neighborhoods will also be within 60, 65, or higher LDN contours, thus being eligible for other programs.

Table 7.04 identifies the neighborhoods and schools impacted by SEL noise.

Table 7.04
Neighborhoods Identified for SEL
Sound Insulation and Avigation Easements

City	Area	Amount
Burien	**Neighborhoods (2)**	
	North Central neighborhood	$18.3 million
	Central neighborhood	$5.8 million
	Total - Burien	**$24.1 million**
Des Moines	**Neighborhoods (2)**	
	Redondo neighborhood	$7.9 million
	Downtown neighborhood	$4.1 million
	Total - Des Moines	**$12.0 million**
Federal Way	No neighborhoods in Federal Way have been identified for SEL insulation and easements.	**$0.0 million**
Normandy Park	**Neighborhoods (2)**	
	Bonniewood neighborhood	$1.5 million
	North neighborhood	$13.0 million
	Total - Normandy Park	**$14.5 million**
Tukwila	**Neighborhoods (5)**	
	Allentown neighborhood	$13.0 million
	Cascade View neighborhood	$11.4 million
	Foster neighborhood	$18.2 million
	Thorndyke neighborhood	$15.7 million
	Riverton neighborhood	$10.3 million
	Total - Tukwila	**$68.6 million**
(No Highline School District or Highline Community Hospital facilities have been identified for SEL insulation and easements.)		
Total Study Area		**$119.2 million**

While insulation and avigation easements are less disruptive than acquisition and redevelopment, there is still the potential to change the character of the neighborhood.

It is recommended that the neighborhoods identified in Table 7.04 be further studied to determine the full extent of the proposed insulation and easement program. This study should be completed prior to construction of the Third Runway.

7.04 - NOISE AND VIBRATION - OVERFLIGHT MITIGATION

Neighborhoods that are subjected to direct overflights of arriving and departing aircraft often experience psycho-acoustic noise impacts (aircraft noise appears louder because the aircraft is visible). Departure operations are approximately three times as loud as arriving operations (depending on the specific aircraft), due to the different power requirements associated with climb-out. Figure 7.02 shows the projected arrival and departure flight-tracks that were included in the Airport's EIS.

Some neighborhoods impacted by overflights may already be mitigated by programs associated with LDN and SEL remediation. For those that are outside these areas, it is recommended that further sound abatement insulation and avigation easements be offered to the neighborhoods in question. An alternative method for mitigating these areas is for the flight tracks and arrival/departure procedures to be modified to avoid direct overflights of populated areas.

Table 7.05
Neighborhoods Identified for Overflight
Sound Insulation and Avigation Easements

City	Area	Amount
Burien	**Neighborhoods (1)**	
	Shorewood neighborhood	$22.5 million
	Total - Burien	**$22.5 million**
Des Moines	No neighborhoods in Des Moines have been identified for overflight insulation and easements.	**$0.0 million**

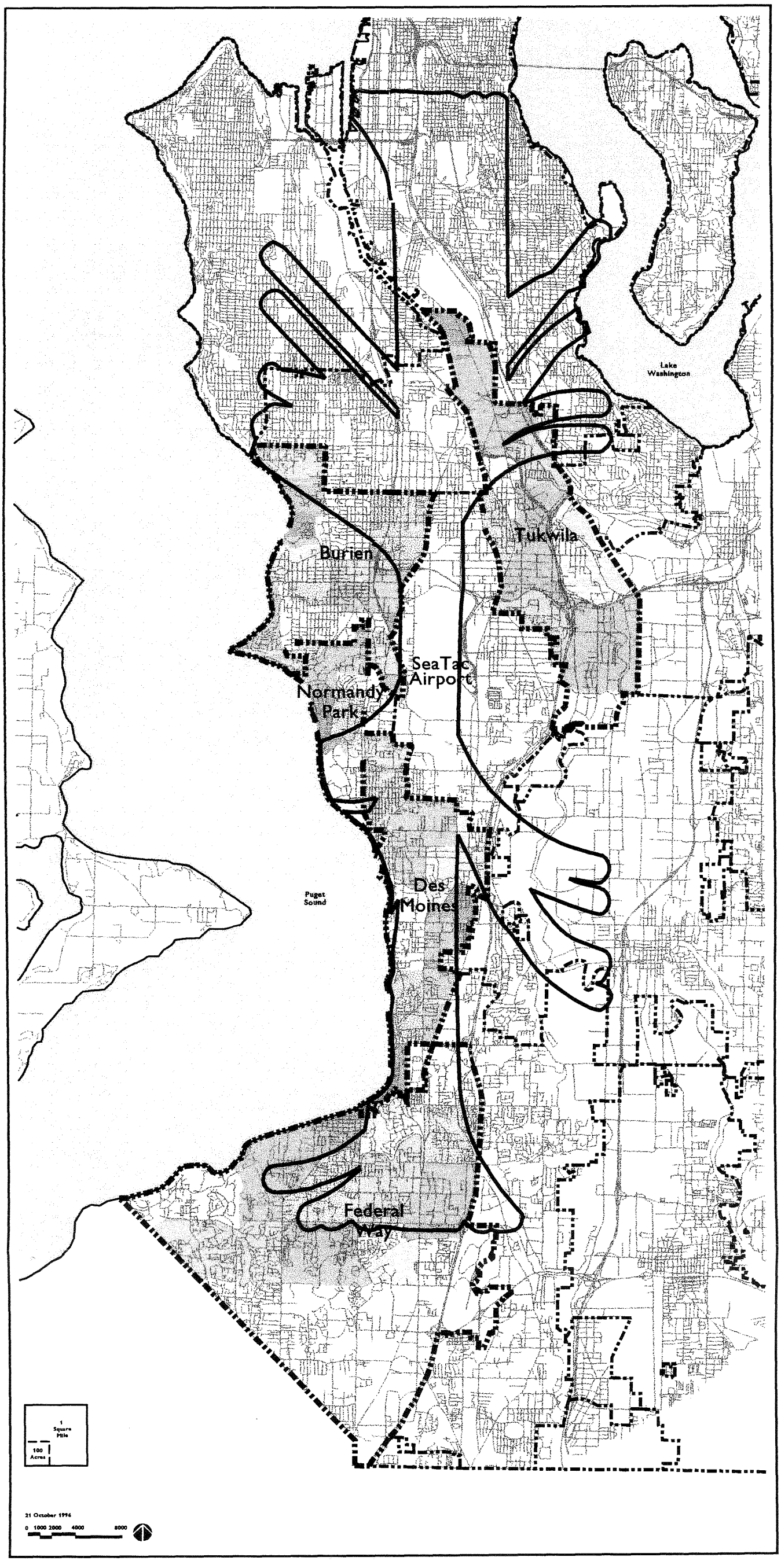
Table 7.05 (continued)

City	Area	Amount
Federal Way	**Neighborhoods (12)**	
	Marine Hills neighborhood	$19.8 million
	Easter Lake neighborhood	$27.3 million
	Steel Lake neighborhood	$13.0 million
	First Avenue neighborhood	$20.5 million
	Kitts Corner North neighborhood	$11.2 million
	City Center neighborhood	$16.1 million
	Mar-Cheri neighborhood	$0
	Dash Point neighborhood	$0
	Lakota neighborhood	$0
	Mirror Lake neighborhood	$0
	Twin Lakes neighborhood	$0
	West Campus neighborhood	$0
	Total - Federal Way	**$107.9 million**
Normandy Park	**Neighborhoods (5)**	
	Riviera neighborhood	$9.0 million
	East Central neighborhood	$9.3 million
	Normandy Province neighborhood	$1.5 million
	Arrow Lake neighborhood	$1.1 million
	South neighborhood	$17.0 million
	Total - Normandy Park	**$37.9 million**
Tukwila	**Neighborhoods (1)**	
	Ryan neighborhood	$4.3 million
	Total - Tukwila	**$4.3 million**
(No Highline School District or Highline Community Hospital facilities have been identified for overflight insulation and easements.)		
Total Study Area		**$172.6 million**

Table 7.05 identifies the neighborhoods and schools that are projected to be impacted by overflight noise as a result of the projected new flight tracks. Neighborhoods identified with a "$0" cost of mitigation are areas that will only require flight track modifications (not insulation and easements).

It is recommended that the neighborhoods identified in Table 7.05 be completely insulated and granted avigation easements as noted prior to operation of the Third Runway.

Figure 7.02
Future Flight Tracks



7.05 - NOISE AND VIBRATION - VIBRATION IMPACTS

In addition to noise, low frequency vibration can affect both individuals and structures. The EIS did not adequately address the projected impacts of noise-induced vibration on the neighborhoods within the study area. Further measurement and modeling will be necessary to adequately address vibration impacts. For neighborhoods that are within the 60 LDN, 65 LDN or higher, other mitigation programs will address vibration impacts. Neighborhoods identified as candidates for acquisition/redevelopment or insulation/easement will also be simultaneously be mitigated for vibration impacts.

The EIS did not provide information on potential impacts of vibration from construction activities. This may be particularly relevant for residences in the vicinity of the earthwork activities. This information should be provided by the Port of Seattle prior to the start of construction of activities associated with Master Plan Update implementation.

7.06 - NOISE AND VIBRATION - ADDITIONAL MITIGATION

Cumulative Construction Noise and Vibration Impacts

A number of other projects are proposed for the Sea-Tac International Airport area. These projects may occur at the same time as Master Plan Update implementation. The EIS had a cursory evaluation of potential construction noise cumulative impacts. A more detailed noise cumulative impacts discussion should be provided by the Port of Seattle prior to the start of construction associated with Master Plan Update implementation. The discussion should include all known proposed projects for the Airport area and projects which could interact with the fill haul routes. Also, this should include appropriate modeling.

Aircraft Noise and Vibration Impacts (Operation)

- **Run Latest Version of INM** - Version 5.1 of the INM was released in late 1996. This is a Windows '95-based version and will has at least the following enhancements: ability to plot noise contours on a street map; and an expanded data base of aircraft including the Boeing 777 and MD90. At the time the EIS was done, noise data for a Boeing 767-200 with JJ-9-D was substituted for the Boeing 777 aircraft.

Because of at least the greater accuracy of the INM, Version 5.1; the ability to plot noise contours on a street map; and the expanded base of aircraft information, the noise model should be rerun by the Port of Seattle using this new version. This will allow confirmation of the data from INM, Version 4.11 and the most up-to-date information available on the newer aircraft noise characteristics.

- **SEL Data** - The EIS noise study did not have an extensive evaluation of sound exposure level (SEL). The INM was used to show the SEL contours for one approach to Runway 16R and one departure from Runway 16L for five aircraft types which dominate the current and future fleet mixes at the Airport. This information should be developed by the Port of Seattle prior to Master Plan Update implementation and should include the SEL contours relationship to health problems, in particular, sleep and speech interference. Thus, this should be done concurrent with re-evaluating the noise data using INM, Version 5.1.

- **55 LDN Contour** - The EIS for the Flight Plan Project (Puget Sound Regional Council and Port of Seattle, October 1992), included noise assessment information associated with the 55 LDN level and a SEL of 80 dBA. This SEL was selected because it is often used to supplement the LDN analysis and 80 dBA corresponds to the level at which sleep disturbance and speech interference start to occur. Similar information should be developed prior to Master Plan Update implementation by the Port of Seattle.

- **Permanent Noise Monitoring** - Currently there are eleven noise monitoring stations. The Port of Seattle is upgrading the noise monitoring system to approximately twenty-five stations. Some of these monitoring stations should be located along the EIS predicted noise contours and consideration should be given to the need for additional stations if the twenty-five stations are deemed inadequate.

- **Arrivals Only** - The need for the proposed Third Runway is based on flight delays during inclement weather for arrivals. Therefore, the Third Runway should be used only for landings. This will help control noise levels associated with departures.

- **Runway Use Restriction** - There should be no arrivals on the Third Runway, except for emergencies, between 9:00 PM and 7:00 AM.

- **Additional Reviews** - As part of all FAR Part 150 reviews, a working group/oversight commission should be allowed to participate with the FAA and other parties. Near-term reviews should include at least the following:

  - An evaluation of the actions needed to apply, monitor and enforce the North Flow Daytime Departure Duwamish/Elliott Bay Noise Abatement Procedures specified in the 1990 Noise Mediation Agreement. Investigate, and if possible, implement the use of this corridor during periods of lighter activity such as midmorning and mid-afternoon.

  - An evaluation of the feasibility of extending the "nighttime" hours of use for the North Flow Nighttime Departure Noise Abatement Procedures from 10:00 PM to 6:00 AM to the evening "shoulder" of 8:00 PM to 10:00 PM, and to the early morning "shoulder" of 6:00 AM to 7:00 AM.

- A re-evaluation of the use of "minimum population exposure" flight tracks, in light of the increase in flight operations and the shift in the overall importance of arrival noise as Stage 2 aircraft are phased out.

- An evaluation of the potential net benefits of preferential runway use during "low activity" periods (e.g., would more use of the east runway result in reduced overall population noise exposure?), coupled with an expanded residential insulation and acquisition program, as needed.

- An evaluation of types of land uses and their compatibility with Airport operations in all areas affected by noise should be conducted based on noise contours at the 55, 60, 65, 70 and 75 LDN.

- **Additional Threshold Data** - The EIS also did not provide detailed information about the threshold above (TA) noise metric with respect to sensitive noise receptors such as schools, hospitals, etc. This information should be developed by the Port of Seattle as part of the re-evaluation of the noise data using the INM, Version 5.1.

- **Engine Run-Ups** - Permanent and/or portable "hush houses" should be used in conjunction with engine maintenance activities, in particular run-ups.

- **Noise Abatement** - The Port of Seattle should continue the following aircraft noise reduction/abatement programs including:

  - *Noise Budget Program* - The Airport will move toward an all Stage 3 aircraft fleet by limiting the amount of noise airlines are allowed to make each year; the goal agreed to in the Noise Mediation Agreement (Port of Seattle and Mestre Greve Associates, 31 March 1990) is to reduce noise by the Year 2001.

  - *Nighttime Limitations Program* - This program involves phasing out Stage 2 aircraft during nighttime hours; effective 1 October 1995, Stage 2 jet aircraft may not operate between 10:00 PM and 7:00 AM unless granted an exemption or variance (e.g., delays due to weather, air traffic control delays, etc.).

  - *Ground Noise Control Program* - Aircraft are not allowed to back away from gates using engine power, instead they must be pushed away by "tugs". Run-ups during the daytime are allowed only at designated locations on the north and south ends of the Airport (aircraft must face into the wind so that jet blast is directed back across the airfield); between 10:00 PM and 7:00 AM. Run-ups are allowed only under special circumstances such as for a departure.

  - *Overflight Noise Abatement Procedures* - Initial "straight-out" departure corridors are in a narrow flight path; Duwamish/Elliott Bay corridor for arriving and departing flights keep aircraft over water and industrial areas as much as possible; nighttime procedures to keep flights over Puget Sound waters as much as possible.

- *Flight Path Manitoring* - The Airport's Noise Abatement Office monitors jet flights in the noise abatement corridors.

- *Noise Monitoring* - Eleven station permanent noise monitoring system to record noise exposure levels in the Airport area should be used until the system has been expanded to at least 25 stations.

- *24-Hour Noise Information Line* - Provides information on noise issues or accepts noise complaints.

- **Nighttime Noise Budget** - In Appendix R of the EIS, it is indicated that the nighttime noise budget and limitations program is designed to address noise issues associated with aircraft categorized as having FAR Part 36 Stage 2 noise levels. Therefore, the program will expire with the completion of the scheduled phase out of these aircraft between 2000 and 2003. These two components are an integral part of the aircraft noise reduction/abatement programs and the Port of Seattle should continue the implementation of the nighttime limitations program beyond the Stage 2 phase out schedule. Depending on the status of the nighttime noise budget program in relation to Stage 3 aircraft, this program also should be continually evaluated and updated based on the different stages of aircraft.

- **Re-Run INM for Run-Ups** - INM Version 4.11 has the capability to compute noise levels due to airplane engine run-up operations. This is particularly useful for noise information around airplane maintenance facilities. Because concern has been expressed about noise levels associated with existing run-up and maintenance operations, and the proposed south aviation support area activities, a discussion of this feature and data for the Sea-Tac International Airport should be provided by the Port of Seattle for both the existing and future conditions.

- **INM Parameters** - A number of assumptions must be made which can affect the outcome of the INM. Sensitivity tests can be used to evaluate how much change in a key input value or assumption might affect the outcome. A similar approach would be useful in evaluating the assumptions used in the future noise modeling and the resultant data in the EIS. Thus, sensitivity tests should be conducted and evaluated by the Port of Seattle.

  Also, if possible, information on the range and standard deviations of the LDN and other data in the EIS should be presented. The range and standard deviations of the data could provide an indication of potential impacts beyond the noise contours shown in the EIS.

- **Noise Mediation Agreement** - The noise mediation agreement (Port of Seattle and Mestre Greve Associates, 31 March 1990) indicates that as technology with noise barriers develops, the Port of Seattle will evaluate their use. It is not clear if during the future conditions evaluation the use of noise barriers was included. This may be particularly useful in the vicinity of any new maintenance facilities in addition to the use of "hushing" equipment. Appendix R of the EIS also mentions the use of vegetation to help reduce noise. The EIS indicates in Chapter 1 that as part of the Master Plan Update objectives, Airport noise is to be attenuated through the use of berms and barriers (Port of Seattle, May 1994).

The Port of Seattle should provide information on the status of using noise barriers at Sea-Tac International Airport and if this was included in the EIS noise modeling.

- **Amend the Four-Post Plan** - The Port of Seattle should provide information on amending the FAA Four-Post Plan in order to minimize low-altitude overflights of residential areas as discussed in the Flight Plan Project EIS (Puget Sound Regional Council and Port of Seattle, October 1992).

- **New Technologies** - The Port of Seattle should provide information on the status of implementing new technologies such as Microwave Landing System (MLS) and Global Positioning Satellite System (GPS) as part of potentially reducing noise impacts to areas around the Airport.

- **Aircraft Operations** - Appendix C Noise impacts in the EIS indicates that existing aircraft operations were based on average daily operations. It is not completely clear how many operations per hour this equates to. The air quality analysis used an aircraft peak hour activity level of about 88 operations (43.9 arrivals and 43.9 departures). The relationship, if any, between the noise and air quality aircraft operations or activity levels should be explained better by the Port of Seattle taking into consideration the noise and air quality analyses used the August and June 1994 Official Airline Guide (OAG), respectively. Also, the discussion should include comments on the Airport being able to accommodate 60 arrivals per hour which was recently mentioned by the Port of Seattle (26 March 1996; 1 August 1996).

- **Reduced Noise Levels** - The Port of Seattle should provide information on the ability to maintain the Airport's reduced noise level goals. This discussion is particularly relevant because of the recent concerns about the Port not sufficiently reducing on-the-ground noise impacts by 1 April 1996 (Puget Sound Regional Council, 27 March 1996).

- **Low Frequency Noise and Vibration** - The Port of Seattle should investigate methods and provide a report for mitigating low frequency noise and vibration.

Run-Up, Departure Roll, Thrust Reverse, Taxi, Idle and Auxiliary Power Noise

Sea-Tac International Airport's Ground Noise Study Phase II (Mestre Greve Associates, 20 February 1994) provided information on findings concerning noise impacts from aircraft engine run-up, departure roll, thrust reverse, taxi, idle and auxiliary power. In addition, recommendations on these areas were made. However, more information should be provided by the Port of Seattle on the below listed recommendations in order to evaluate their status and the need for additional studies/measures to help reduce Airport noise impacts.

- **Run-Up Mitigation** - The use of monitoring data to identify aircraft run-up noise including placing monitoring stations near run-up locations and sending the noise data to the noise office for recording. Documentation of the number and type of run-ups and what role they play in the total ground noise impact. Information on technological advances in run-up noise control facilities and their implementation at the Airport.

- **Departure Roll Noise Mitigation** - Information on the status of limiting operations of Stage 2 aircraft and their complete elimination during nighttime operations. Documentation that the noise insulation program takes into consideration mitigation of noise at lower frequencies to account for the lower frequency of Stage 3 aircraft.

- **Thrust Reverser Noise Mitigation** - Results of a taxiway use study; the development of a new taxiway system at the Airport; and a nighttime taxiway use plan to help reduce thrust reverser noise. Results of the Port of Seattle working with airlines to implement procedures that take advantage of the additional stopping distance to minimize the use of thrust reversers during the nighttime hours.

- **Taxi and Idle Noise Mitigation** - Measures to minimize the number of aircraft queuing at the runway ends during peak activity time periods (e.g., gate hold procedures and capacity enhancement measures). Use of a location at the north/south ends of the Airport for conducting pre-departure engine run-up so that noise is directed towards the buy-out areas, in particular at night. Study of various runway and taxiway designs on aircraft queuing and the resulting taxi and idle noise. Feasibility of constructing a noise berm at the west boundary of the Airport near the runway ends in order to help mitigate taxi and idle noise at the runway ends.

- **Auxiliary Power Noise Mitigation** - Steps to install fixed power at gates, etc., to minimize the use of auxiliary power, in particular during the nighttime hours. Installation of fixed power systems that include preconditioned air. Identification of the source of long duration steady state noise in the north cargo area and its mitigation.

On-The-Ground Reduction of Nighttime Noise Impacts

- **North Flow Noise Abatement** - The Port of Seattle and Federal Aviation Administration should more aggressively enforce compliance with the North Flow Nighttime Departure Noise Abatement Procedures and provide evidence of this enforcement (e.g., copies of notices of violations to airlines).

- **Nighttime Restrictions** - The Port of Seattle should provide evidence of the continuing effort to minimize flights between 10:00 PM and 6:00 AM.

- **Limit Nighttime Variances** - The Port of Seattle should provide evidence of its efforts to minimize the number of variances issued for the Nighttime Limitations Program.

- **Stage 2 Aircraft** - The Port of Seattle should provide evidence of its working with owners/operators of Stage 2 aircraft (including those under 75,000 pounds) which are currently exempt from the Nighttime Limitations Program, to obtain their cooperation in minimizing or eliminating the use of these aircraft between 9:00 PM and 7:00 AM.

- **Stage 3 Aircraft** - The Port of Seattle should provide evidence of its efforts to ensure the use of Stage 3 aircraft by airlines, in particular foreign airlines.

- **Engine Run-Ups** - The Port of Seattle should provide evidence of its continuing to work with airlines to minimize nighttime engine run-up. This should include the use of hush houses.

Vibration

The EIS vibration analysis should be expanded by the Port of Seattle to include qualitative and quantitative information on at least the following items for residences, schools and hospitals in the Airport area - human whole body vibration, annoyance and interference to humans caused by building vibration, and building structural damage.

With respect to humans, the evaluation should look at impacts on working efficiency, health, safety and comfort. The evaluation should incorporate the information and methodology discussed by the International Organization for Standardization (ISO; International Organization for Standardization, 1985a and b; 1989).

Cumulative Impacts

Other area projects which may be in operation concurrent with Master Plan Update implementation were only briefly discussed in the EIS noise analysis. In order to more adequately address the relationship between these projects and the activities associated with Master Plan Update implementation, the cumulative impacts discussion should be re-evaluated by the Port of Seattle. This should include appropriate modeling. The evaluation also should include all known proposed projects in the Airport area.

7.07 - AIR QUALITY - AIRCRAFT EMISSIONS MITIGATION

Increased air emissions as a result of increased aircraft activity have not been adequately addressed in the Airport's EIS. The EIS showed air sample data from monitors located 5 miles away from the Airport. With prevailing winds and aircraft altitude, aircraft emissions pose a regional problem. **Indeed, the potential for air quality impacts exists in every neighborhood in the five impacted communities**.

To mitigate the impacts of aircraft emissions, a runway utilization program should be developed by the Airport to minimize on-ground operations and queuing for departures and for arrival gates. Acceleration of the introduction of Stage 3 aircraft (which are more fuel efficient and less polluting) will also positively effect air emissions.

Acceleration of Stage 3 aircraft is already being initiated by many airlines. This mitigation measure, therefore, has no costs associated with it that are attributable to the Port of Seattle or any public agency.

7.08 - AIR QUALITY - VEHICULAR CARBON MONOXIDE MITIGATION

Increased activity at Sea-Tac will result in increased vehicle-trips. This increased traffic has the potential to overload existing road-ways and intersections. Additional traffic demand studies will be necessary to allocate traffic to specific "magnets" (such as the Airport).

Intersection improvements may run $500,000 per intersection, plus $100,000 per city for traffic improvement studies. However, additional improvements to be made to reduce traffic noise (see Section 8) will also positively impact intersections and traffic-flow.

Therefore, to avoid "double-counting", all intersections identified in Section 8 for improvements associated with traffic noise improvements will simultaneously improve carbon monoxide "hot spots".

7.09 - AIR QUALITY - VEHICULAR HYDROCARBON MITIGATION

Increased activity at Sea-Tac will result in increased vehicle-trips. This increased traffic has the potential to increase hydrocarbon emissions, associated with high-volume, high-speed traffic. Additional traffic demand studies will be necessary to allocate traffic to specific "magnets" (such as the Airport). However, many traffic-related problems may be already resolved by improvements designed to address traffic noise/LEQ impacts (see Section 8). Therefore, to prevent "double-counting", all intersections identified in Section 8 for improvements associated with traffic noise improvements will simultaneously improve traffic-flow and hydrocarbon impacts.

7.10 - AIR QUALITY - AIR TOXICS MITIGATION

Neighborhoods located under or near flight tracks (Figure 7.02) may also experience pollution by air toxics associated with aircraft. With the exception of neighborhoods that are redeveloped, most of these areas cannot be protected from these impacts. The modification of flight tracks and acceleration of Stage 3 aircraft use will help to reduce the potential for these impacts.

As stated in Section 7.07, the introduction of newer, cleaner Stage 3 aircraft, combined with flight track modifications, will have the most positive impact in the study area. These improvements are either currently being made (as in the case of acquisition of new aircraft by airlines) or can be accommodated for virtually no cost (flight track modifications). However, this study also recommends a long-term investigation into the effects of air toxics on human health.

7.11 - AIR QUALITY - FUGITIVE EMISSIONS MITIGATION

Dust associated with the construction of the Third Runway will impact neighborhoods that are adjacent to the north, south, and west sides of the Airport., specifically:

- **Burien** - North East, East Central, and South East neighborhoods.
- **Des Moines** - North Hill, West Central, North Central, and East Central neighborhoods.

It is recommended that a Dust Control Plan be included in the contractor's permit to address these impacts. Measures should include wetting down of the construction area, wetting down and covering stockpiled fill material, and covering of haul trucks on and off-site. The requirement of a Dust Control Plan should be satisfied prior to construction of the Third Runway.

7.12 - AIR QUALITY - POINT SOURCE MITIGATION

On-Airport pollution associated with both the construction and operation of the Third Runway will impact neighborhoods that are adjacent to the north, south, and west sides of the Airport., specifically:

- **Burien** - North East, East Central, and South East neighborhoods.
- **Des Moines** - North Hill, West Central, North Central, and East Central neighborhoods.

Individual on-Airport sites may contribute to air pollution and has the potential to impact neighborhoods that are north, south, and west of the Airport. Fueling operations associated with aircraft, rental cars, and other motor pools should include vapor recovery systems and the use of oxygenated or alternative fuels (as appropriate). On-Airport pollution control equipment and air quality monitors should be installed as part of the rebuilding of Sea-Tac Airport.

7.13 - AIR QUALITY - ADDITIONAL MITIGATION

Re-Analysis

Once the sources of fill material are known and the haul routes have been identified and approved, the construction vehicle air quality analysis should be re-evaluated and the dispersion analysis should be re-done in order to better predict potential air quality impacts prior to the start of construction. The analysis should extend from the Airport area to the fill source areas.

Particulate Matter

As part of the re-evaluation of the construction vehicle air quality analysis, the Port of Seattle should work with appropriate regulatory agencies to obtain PM_{10} data which is more representative of the Puget Sound Region. This should entail the establishment of additional air quality monitoring stations, in particular in the vicinity of the Airport.

Air Quality Monitoring

As part of construction activities, PM_{10} and CO should be monitored in the vicinity of the fill sources, along the haul routes and in the Airport construction area.

Fugitive Dust

During construction at least the following measures should be used to reduce fugitive dust emissions:

- Appropriate materials should be applied at the source fill areas and Airport construction areas to control fugitive dust emissions; if chemicals are used, Material Safety Data Sheets (MSDS) should be provided which show that the materials have a low adverse risk to humans and the environment.

- To reduce soil deposits on roads and subsequent fugitive dust, the Port of Seattle should implement procedures for minimizing tracking of soil on area roads at all construction areas including the source fill areas.

- The Port of Seattle should use gravel, paving and revegetation as appropriate to control fugitive emissions during construction.

Other Construction Requirements

- **Covered Trucks** - The Port of Seattle should ensure that all trucks hauling fill material should be covered to control fugitive dust emissions.

- **Emissions Control Devices** - All construction equipment should have appropriate emissions control devices and should comply with the vehicle inspection program.

- **Vehicle Maintenance** - All construction equipment should be well maintained to reduce emissions.

- **Vehicle Idling** - All construction vehicles should avoid prolonged periods of vehicle idling.

- **Batch Plants** - If concrete batch plants are used during construction, the Port of Seattle should provide documentation of their compliance with appropriate regulatory requirements.

- **Additional Study** - The Port of Seattle should provide a more detailed evaluation of cumulative impacts on air quality of construction associated with Master Plan Update implementation and other known proposed projects in the Airport area.

Air Quality Mitigation (Operation)

- **Clean Air Act Conformity** - The Port of Seattle should provide information on Master Plan Update implementation Clean Air Act Conformity. This should include at least the following - a copy of draft analysis/plan for review and comment; a copy of draft final analysis/plan for review and comment; and copies of the EPA, PSAPCA, DOE and any other approvals for the conformity analysis/plan.

- **Certification of Compliance with Air Quality Standards** - The Port of Seattle should provide at least the following information on the State of Washington's Certification of Compliance with Air Quality Standards - copy for review of documentation submitted to the Governor's Office and a copy of Governor's Air Quality Certificate.

- **Additional Air Monitoring** - The closest DOE and PSAPCA monitoring sites are approximately 5 miles from the Airport; there are no monitoring sites west, northwest and southwest of the Airport; CO and PM_{10}, are the most frequently monitored parameters; in order to make monitoring information such as this more useful; permanent monitoring stations should be established in and around the Airport area. Parameters monitored should include the AAQS parameters as well as toxic pollutants of concern such as 1,3 - butadiene, formaldehyde and benzene; quarterly monitoring reports should be provided which discusses the monitoring data with respect to AAQS and State of Washington ASILs.

- **Location of Air Monitors** - Air quality monitoring stations should be located in areas which have historically had complaints, even though the EIS screening analysis did not show violations of AAQS.

- **Area Dispersion Analysis** - After one year of baseline data has been collected at the new air quality monitoring sites, the area dispersion analysis should be re-evaluated by the Port of Seattle for both the existing and future conditions.

- **Mobile Sources** - The Port of Seattle should re-evaluate the existing and future roadway intersection analysis to confirm the accuracy of the evaluation in the EIS and to correct for the following inconsistencies discussed by EPA (6 June 1996):

  "The modeling results for air quality in the Sea-Tac International Airport Final EIS conflict with those from the draft EIS for the SR 509/South Access Road Corridor Project at two intersections (both EISs used the same models). The two EIS's model conflicting results for existing conditions and future action alternatives at South 188th and International Boulevard, and South 200th and International Boulevard for the average CO concentrations indicated on page 4-7 in the SR 509 EIS, as compared with the same analyses on page IV.9-11H in the Sea-Tac International Airport Final EIS. Both analyses model CO violations for existing conditions, but for future action alternatives the Sea-Tac International Airport analysis shows modeled CO violations where the SR 509 analysis does not."

  "Modeled air quality impacts at South 200th and International Boulevard are shown in the South Aviation Support Area Final EIS (pages 4-106 to 109 and 112), the 28/24th Street Arterial Final EIS (page 3.22) and the CTI Final EIS (page 4-7, 8). The results vary for each project ranging from 5.0 to 13.3 parts per million CO."

- **Port Vehicles** - All Port of Seattle and vehicles associated with Airport operations should comply with required vehicle emissions inspections and maintenance programs.

- **Air Toxics** - The Port of Seattle should provide information on the following or conduct the indicated studies related to air toxics:

  - Long-term air toxics data should be collected in the Airport area throughout different months of the year.

  - The Port of Seattle should conduct an evaluation of health problems in addition to cancer, in the Airport area; the study should include schools, hospitals, nursing homes and residences.

  - The Port of Seattle should conduct a study to determine the nature and extent of fuel odor problems in the Airport area; the study should include an evaluation of increased odors during inclement weather.

  - The Port of Seattle should collect appropriate data in order for a cancer risk assessment to be conducted in the Airport area.

  - The Port of Seattle should provide information on vapor recovery and regulatory compliance for all facilities associated with Airport operations including rental car and airline operations.

- **Queuing and Taxiing** - The Port of Seattle should conduct a study to determine if it is possible to reduce aircraft emissions by improving Airport operations associated with queuing and taxiing.

- **Master Plan Update** - As Master Plan Update implementation proceeds, the air dispersion and roadway traffic analysis should be re-evaluated by the Port of Seattle in order to accurately monitor potential impacts.

Cumulative Impacts

The EIS contained a brief discussion of cumulative impacts associated with air quality issues. The Port of Seattle should provide a more detailed evaluation of cumulative impacts on air quality and should include the known projects planned for the Airport area during operation of the Master Plan Update activities.

7.14 - SURFACE WATER QUALITY AND HYDROLOGY - RUNOFF VOLUME MITIGATION

Upstream development will decrease the amount of permeable surface available to absorb stormwater runoff, thus increasing the runoff coefficient. A stormwater management plan will be necessary to avoid inundating downstream properties (retention or detention ponds may be a component of such a plan). Neighborhoods that have a stream, creek or river that conveys water from or through the Airport may be affected by the Third Runway.

Additional runoff volume may result from a decrease in permeable surface within the drainage-shed. Further studies should be conducted to determine the specific "floodprone" areas. Figure 7.03 shows the streams and creeks in the study area. Table 7.06 identifies the neighborhoods which are prone to stormwater runoff impacts.

Table 7.06
Neighborhoods Identified for Stormwater Runoff Mitigation

City	Area	Amount
Burien	**Neighborhoods (4)**	
	North East neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
Des Moines	**Neighborhoods (3)**	
	North Hill neighborhood	$ to be determined
	West Central neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for stormwater runoff mitigation.	$0.0 million
Normandy Park	**Neighborhoods (5)**	
	Bonniewood neighborhood	$ to be determined
	Highlands neighborhood	$ to be determined
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for stormwater runoff mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for stormwater runoff mitigation.)		
Total Study Area		**$ to be determined**

7.15 - SURFACE WATER QUALITY AND HYDROLOGY - EROSION AND SEDIMENT MITIGATION

Neighborhoods that have a stream, creek or river that conveys water from or through the Airport may be affected increased erosion and sediment as a result of the Third Runway project. As above, a stormwater management plan should address the impacts. Table 7.07 identifies the neighborhoods which are prone to stormwater runoff impacts.

Figure 7.03
Streams and Waterways

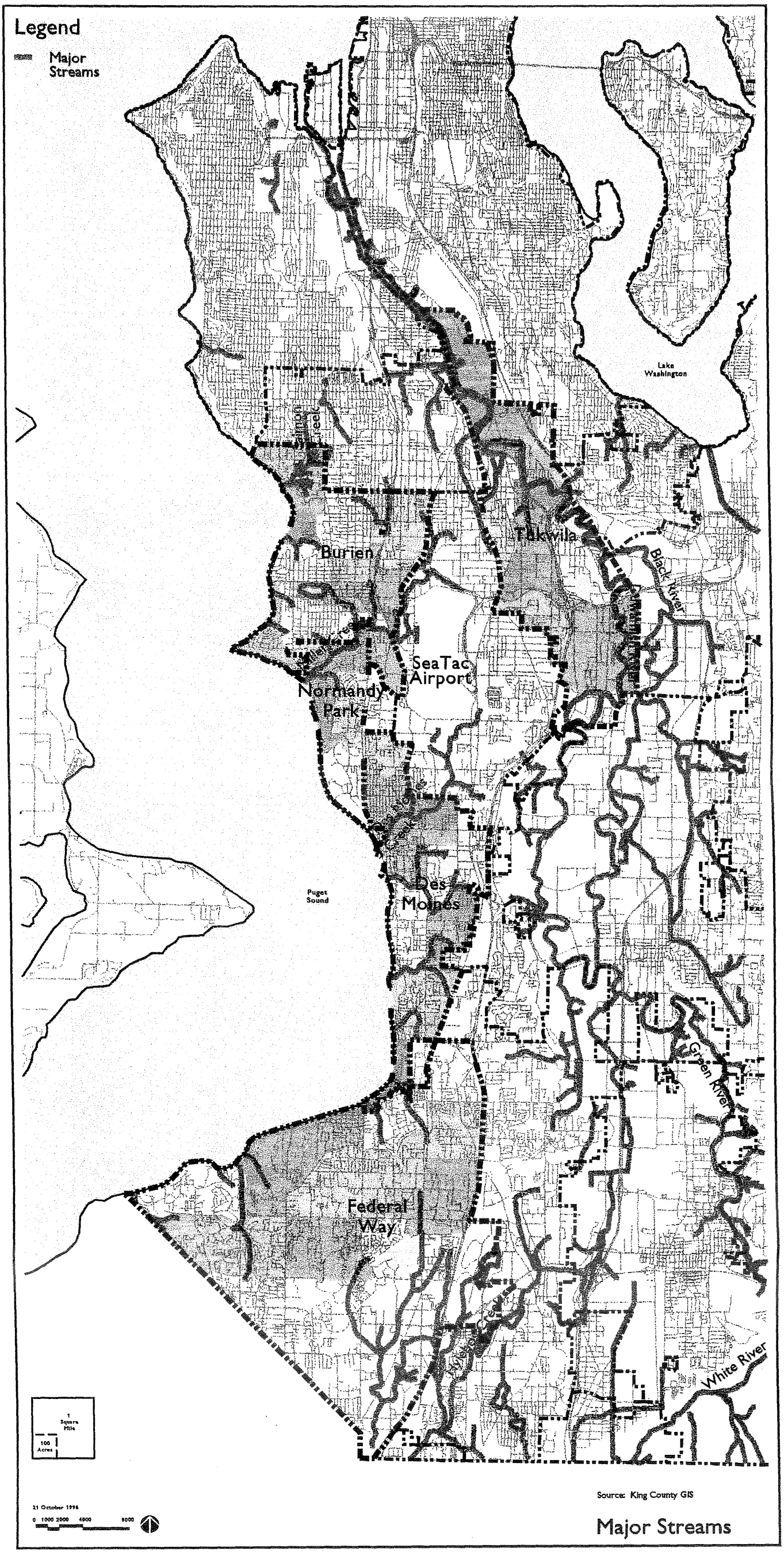


Figure 7.04
Wetlands

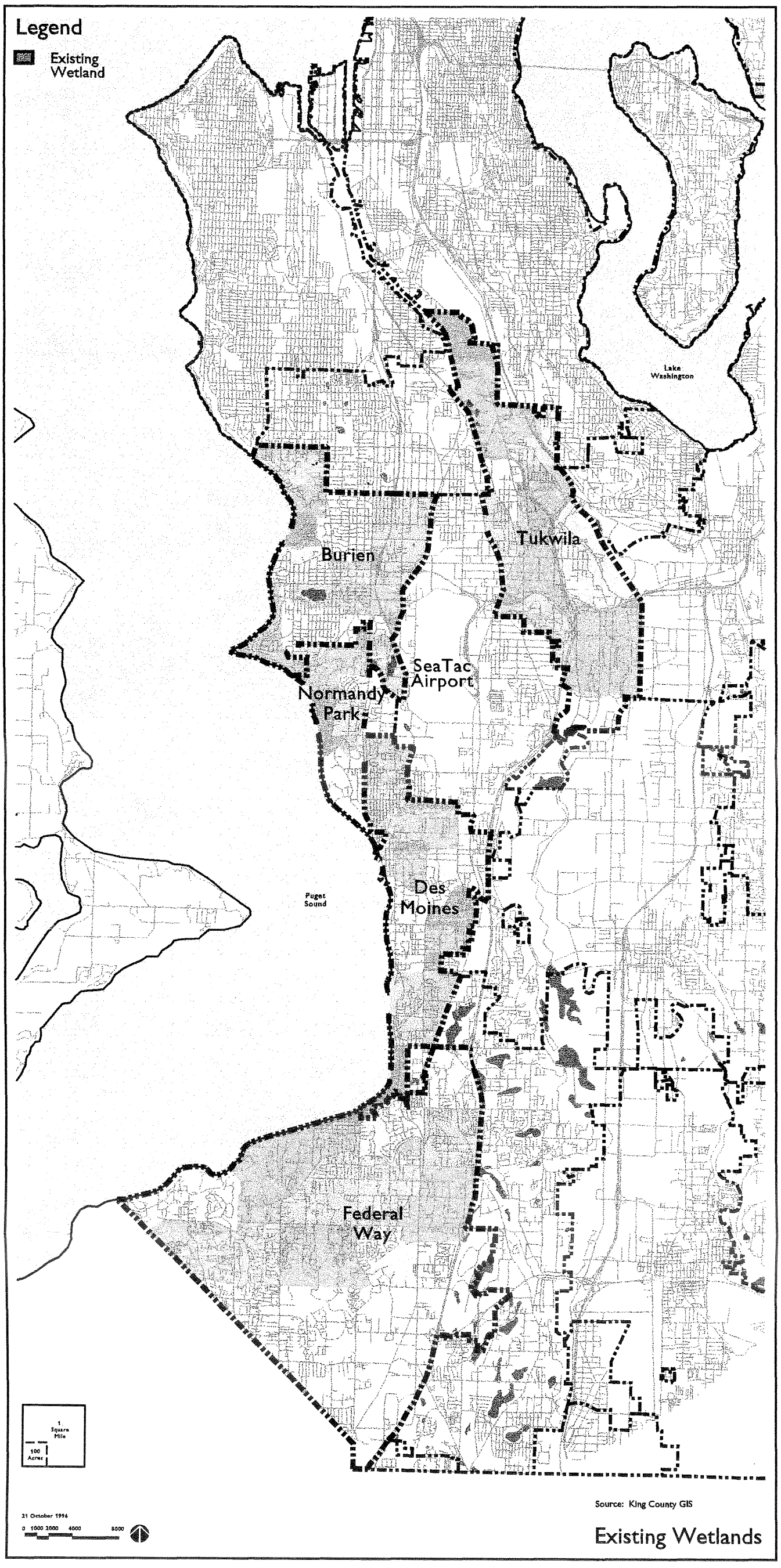


Figure 7.05
100-Year Floodplains

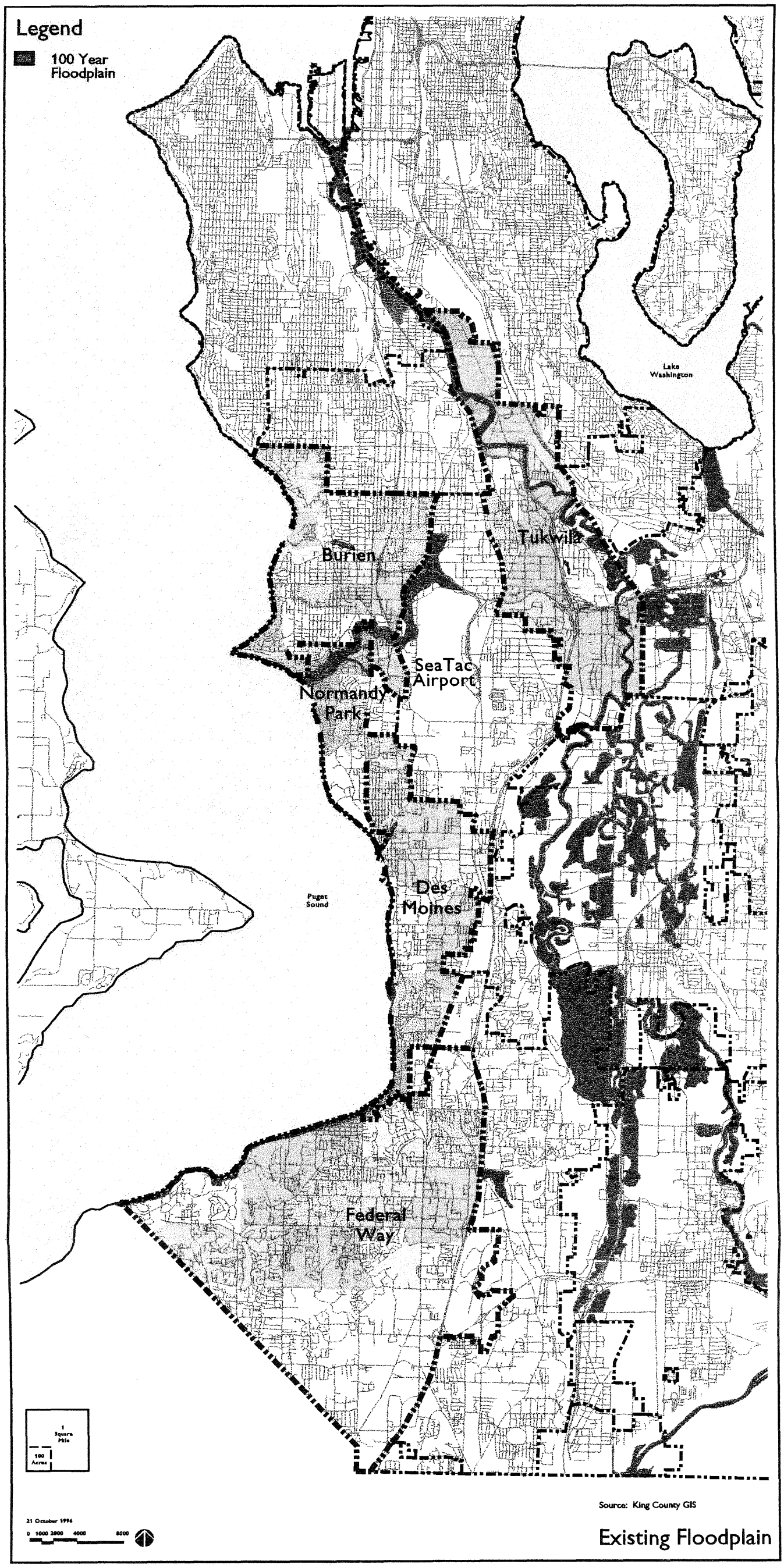


Table 7.07
Neighborhoods Identified for Erosion and Sediment Mitigation

City	Area	Amount
Burien	**Neighborhoods (4)**	
	North East neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
Des Moines	**Neighborhoods (3)**	
	North Hill neighborhood	$ to be determined
	West Central neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for erosion and sediment mitigation.	$0.0 million
Normandy Park	**Neighborhoods (5)**	
	Bonniewood neighborhood	$ to be determined
	Highlands neighborhood	$ to be determined
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for erosion and sediment mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for erosion and sediment mitigation.)		
Total Study Area		**$ to be determined**

7.16 - SURFACE WATER QUALITY AND HYDROLOGY - SPILL MITIGATION

Neighborhoods that have a stream, creek or river that conveys water from or through the Airport may be affected by the Third Runway. These waterways may convey pollutants that are spilled on Airport property. The Airport should design an on-site containment system as part of the Third Runway to assure that all on-site spills are contained within the Airport. Additionally, operational controls for maintenance and fixed-base operators (FBOs) should be considered to further diminish the potential for contamination. Table 7.08 identifies the neighborhoods which could be impacted by on-Airport spills.

Table 7.08
Neighborhoods Identified for On-Airport Spill Mitigation

City	Area	Amount
Burien	**Neighborhoods (4)**	
	North East neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
Des Moines	**Neighborhoods (3)**	
	North Hill neighborhood	$ to be determined
	West Central neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for spill mitigation.	$0.0 million
Normandy Park	**Neighborhoods (5)**	
	Bonniewood neighborhood	$ to be determined
	Highlands neighborhood	$ to be determined
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for spill mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for spill mitigation.)		
Total Study Area		**$ to be determined**

7.17 - GROUND WATER QUALITY AND HYDROLOGY - AQUIFER RECHARGE ZONE IMPACTS

The Airport's EIS addressed the Highline Aquifer and other aquifers, but did not delineate their total known limits. Additional studies should be undertaken to assure that the total recharge zone for these aquifers is protected. Any areas that are affected should be replaced. The previously-recommended stormwater management plan also will help control ground water pollution.

Table 7.09 identifies the neighborhoods which could be impacted by reduction of the Highline Aquifer recharge zone.

Table 7.09
Neighborhoods Identified for Highline Aquifer Mitigation

City	Area	Amount
Burien	**Neighborhoods (12)**	
	Shorewood neighborhood	$ to be determined
	North Central neighborhood	$ to be determined
	North East neighborhood	$ to be determined
	Seahurst Park neighborhood	$ to be determined
	Seahurst neighborhood	$ to be determined
	Central neighborhood	$ to be determined
	Lake Burien neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	South West neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Des Moines	**Neighborhoods (10)**	
	North Hill neighborhood	$ to be determined
	West Central neighborhood	$ to be determined
	North Central neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Zenith neighborhood	$ to be determined
	South Des Moines neighborhood	$ to be determined
	West Woodmont neighborhood	$ to be determined
	East Woodmont neighborhood	$ to be determined
	Redondo neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for Highline Aquifer mitigation.	$0.0 million
Normandy Park	**Neighborhoods (9)**	
	Bonniewood neighborhood	$ to be determined
	Highlands neighborhood	$ to be determined
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	Manhattan neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Normandy Province neighborhood	$ to be determined
	Arrow Lake neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for Highline Aquifer mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for Highline Aquifer mitigation.)		
Total Study Area		**$ to be determined**

7.18 - GROUND WATER QUALITY AND HYDROLOGY - AQUIFER CONTAMINATION MITIGATION

As in Section 7.17, neighborhoods that rely upon the Highline Aquifer may experience an increased potential for contamination of the water supply. The pollution control measures outlined above would also serve to minimize or eliminate this potential hazard. The same neighborhoods identified in Table 7.08 may be at risk for contamination to the Highline Aquifer.

7.19 - ADDITIONAL SURFACE/GROUND WATER MITIGATION MEASURES

Geotechnical Engineer

The Port of Seattle should hire for the duration of construction of the Third Runway a geotechnical engineer to ensure that fill is placed appropriately including compaction and to help detect and remove seismically unstable soils, such as in fill sources.

Toxic-Free Fill

The Port of Seattle should provide evidence including appropriate certifications that all fill material is free of harmful levels of toxic and hazardous materials as defined by the then-current Federal and State regulations.

Plans for Review

At least 2 months prior to construction, the Port of Seattle should provide for review and approval the following:

- Construction Stormwater Pollution Prevention Plan and Erosion/Sediment Control Plan.
- Spill Prevention, Control and Countermeasure (SPCC) Plan.
- Construction Management Plan.
- Construction Waste Management Plan.
- Geotechnical report.
- Reclamation plan for proposed fill sources.
- Earthwork specifications and drawings, in particular for the Third Runway.
- A copy of the State of Washington Governor's Water Quality Certificate which indicates that there is reasonable assurance that the project will be designed, constructed and operated in compliance with applicable water quality standards.

Monitoring Program

Limited baseline surface and ground water data was provided in the EIS. Therefore, prior to the start of construction the Port of Seattle should establish permanent, long term surface and groundwater monitoring stations in the Airport area. The locations and number of these stations should be approved by a working group/oversight commission.

The locations of the sampling stations should take into consideration previous or on-going water quality studies in the area. This should include at least studies by King County Surface Water Management Division and the Ground Water Management Program (various studies associated with groundwater contamination at Sea-Tac International Airport and the Port of Seattle's Receiving Water Monitoring Study). The report on the latter study will be submitted to the Washington DOE on 30 June 1997. Washington DOE has indicated (Washington DOE, 27 November 1996) that in selecting groundwater monitoring well locations:

> *"It would not be environmentally prudent to drill wells into deep, drinking water aquifers below an area like Sea-Tac Airport with known and unknown areas of shallow soil and perched groundwater contamination at the near surface (particularly free product). Best drilling technology cannot always preclude the spread of surficial contamination to the aquifers at depth through the monitoring wells (sampling stations) themselves."*

The DOE further indicated that a better location for the wells might be at the outer boundaries of the wellhead protection zones. Once the stations have been established, quarterly sampling should be initiated during the months of February, May, August and November. The parameters sampled should include metals and organics such as those associated with Airport operations. The parameters sampled should be selected based upon discussions with appropriate State of Washington and King County regulatory agencies and a working group/oversight commission. Potential parameters to be considered for sampling are shown in Table 7.10 for surface and groundwater.

Highline Aquifer

There is evidence that when wells are pumping from the Highline Aquifer, drawdown can be observer in shallower aquifers (Greg Wingard, 22 July 1996, personal communications; Wingard and Smith, 19 June 1995). This is indicative of interconnection between the aquifers and a potential path for contaminated ground water to the Highline Aquifer. Therefore, ground water movement in the Airport area should be better defined prior to the start of construction by the Port of Seattle. According to the EIS, these additional studies are being conducted. When available, the studies should be reviewed for potential ground water contamination impacts on the Highline Aquifer and other area aquifers.

Table 7.10
Potential Water Sampling Parameters

General		Indicators of Airport, Industrial and Municipal Contaminants	
Surface Water	**Groundwater**	**Surface Water**	**Groundwater**
Water temperature[a]	Depth to groundwater	BOD, 5-day	Chloride
Specific conductance[a]	Water temperature	COD	Oil and grease
pH[a]	Specific conductance	Chloride	Sulfide
Dissolved oxygen[a]	pH	Cyanide	Coliform, total per 100 ml
Flow[a]	Dissolved oxygen	Oil and grease	Coliform, fecal per 100 ml
Acidity	Acidity	Sulfide	Aviation fuel contaminants
Alkalinity	Alkalinity	Coliform, total per 100 ml	Ethylene glycol
Bicarbonate	Bicarbonate	Coliform, fecal per 100 ml	Propylene glycol
Carbonate	Carbonate	Aviation fuel constituents	Gasoline
Calcium	Calcium	Ethylene glycol	
Hardness	Hardness	Propylene glycol	
Color	Color		
Turbidity	Dissolved solids (total)		
Dissolved solids (total)	Suspended solids (total)		
Suspended solids (total)	Fluoride		
Fluoride	Magnesium		
Magnesium	Potassium		
Potassium	Silica		
Silica	Sodium		
Sodium	Sulfate		
Sulfate			
Nutrients		**Trace Elements**	
Surface Water	**Groundwater**	**Surface Water**	**Groundwater**
Ammonia	Ammonia	Aluminum	Aluminum
Kjeldahl nitrogen	Kjeldahl nitrogen	Arsenic	Arsenic
Nitrate	Nitrate	Cadmium	Cadmium
Nitrite	Nitrite	Chromium (total)	Chromium (total)
Phosphorus (total)	Phosphorus (total)	Chromium (hexavalent)	Chromium (hexavalent)
Ortho-phosphorus	Ortho-phosphorus	Copper	Copper
		Iron	Iron
		Lead	Lead
		Manganese	Manganese
		Mercury	Mercury
		Silver	Silver
		Zinc	Zinc

a - In-situ field measurements.

Miller/Des Moines Creek Monitoring Studies

In the EIS it is indicated that the Port of Seattle was to have conducted a monitoring study of Miller and Des Moines Creeks the winter of 1995 to 1996, both upstream and downstream of Airport stormwater discharges. The purpose of this study is to help determine the toxicity of Airport stormwater runoff and surface water quality.

The results of this study should be provided by the Port of Seattle and reviewed by a working group/oversight commission prior to the start of construction.

Stormwater Detention

To minimize the potential impacts of the new impervious areas and drainage areas, new stormwater detention facilities are planned. If the preferred alternative is implemented the hydrologic analysis and stormwater management facilities should be re-evaluated to support final design by the Port of Seattle prior to the start of construction. This is required because the EIS indicates that the stormwater management facilities and discharge locations are conceptual layout. The re-evaluated hydrologic analysis should then be used as part of the baseline to monitor potential Alternative 3 impacts. During large storm events, the effect of possible overflow from the IWS on the receiving waters also should be addressed. The hydrologic analysis and stormwater information should be provided by the Port of Seattle to a working group/oversight commission for review at least 2 months prior to the start of construction.

Wet Vaults/Biofiltration Swales

Limited details on both the construction and operation of the wet vaults and biofiltration swales was provided in the EIS. There was a more lengthy explanation of the constructed aquifer, which the EIS indicates has not been used before to manage stormwater. More detailed design and operating information should be provided on the wet vaults and biofiltration swales by the Port of Seattle at least 2 months prior to the start of construction.

If additional consideration is given to the constructed aquifer, its potential use must be more strongly justified. The Sea-Tac International Airport area may not be the most suitable place to try this technology out; especially considering the controversy over disturbing the headwaters of the two watersheds. The King County Surface Water Management Division has suggested that surface water retention facilities are more innovative and effective. Therefore, they should be considered further before the use of wet vaults and/or the constructed aquifer. The surface water facilities to be considered for modification should include the Lake Reba facility.

Construction Fence

The Port of Seattle must place a construction fence at the outside limits of the construction area.

Fill Material Source

Prior to the start of construction, when the borrow source areas have been identified, the Port of Seattle should conduct baseline studies of any area surface waters and the ground water. This information should be used to describe the existing conditions and to help monitor potential changes after the earthwork activities are complete. Parameters which should be considered for evaluation should be the same as those listed in Table 7.10.

Miller Creek Relocation

Prior to the start of relocating any part of Miller Creek, the Port of Seattle should provide information on the potential impact on the relocation of litigation concerning King County agreeing not to channelize the Creek except in limited amounts in connection with retention facilities.

Water Quality and Hydrology

- **Expansion Storm Drain System Report** - At the time the EIS was issued, a hydraulic analysis with computer program (WATERWORKS) was modeling the proposed Airport expansion storm drain system. The Port of Seattle should provide a copy of the final report for review and comment.

- **Surface/Groundwater Monitoring** - The Port of Seattle should continue the surface and groundwater monitoring which was initiated prior to the start of construction as discussed previously. The need to sample on a quarterly basis should be discussed and adjusted if it is deemed appropriate. Other aspects of the monitoring program which should be discussed should include the parameters being monitored and the number and locations of the monitoring stations. The discussion of the monitoring program components should be a continuous process in order to take advantage of the monitoring data and in order to reflect Airport operations/issues.

- **Borrow Site Hydrology** - The borrow site hydrology monitoring should be continued by the Port of Seattle until adequate information is obtained for comparison with the EIS existing or baseline conditions.

- **Operations Erosion and Sediment Control Plan** - At least 2 months prior to the completion of construction on the Third Runway, the Port of Seattle should provide an operations erosion and sediment control plan, and a stormwater pollution prevention plan.

- **Fuel Handling System** - The existing Airport aircraft fuel handling system has experienced some leaks, in particular in older parts of the system. As part of the Master Plan Update implementation, the Port of Seattle should upgrade and modernize the fuel handling system.

7.20 - WETLAND MITIGATION

Impacts from the proposed project may remove, pollute, reduce, or destroy wetlands. Figure 7.04 shows the wetlands as delineated in the EIS. A plan for the replacement of the wetlands within the same watershed should be completed to keep these natural areas within each City. The only neighborhoods in the study area known to be impacted are within the City of Burien (North East, East Central, and South East neighborhoods).

At least 2 months before the start of construction the Port of Seattle should provide additional justification for wetlands mitigation in the Green River Valley and not the Miller Creek Watershed. This should include evidence of further discussions concerning mitigation in the Miller Creek Watershed with State of Washington and King County regulatory agencies and an approved wetlands mitigation plan from appropriate regulatory agencies.

At least 2 months before the start of construction the Port of Seattle should provide more detailed information on what wetlands will be destroyed as part of Master Plan Update implementation and how other Airport area wetlands will be protected from construction activities.

The Port of Seattle should also initiate a wetlands monitoring program to provide at least yearly reports on the success of the wetlands mitigation plan.

7.21 - FLOODPLAINS - ENCROACHMENT MITIGATION

Neighborhoods within 100-year floodplains may experience a potential for increased flooding and increased contamination following construction of the Third Runway. Figure 7.05 shows the 100-year floodplains in the study area as delineated by the Federal Emergency Management Agency (FEMA). A stormwater retention/detention system will aid in flood control and pollution abatement that may be due to the Third Runway project. Table 7.11 identifies neighborhoods that may experience floodplain encroachment.

Table 7.11
Neighborhoods Identified for Floodplain Encroachment Mitigation

City	Area	Amount
Burien	**Neighborhoods (4)**	
	North East neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
Des Moines	**Neighborhoods (3)**	
	North Hill neighborhood	$ to be determined
	West Central neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for floodplain encroachment mitigation.	$0.0 million
Normandy Park	**Neighborhoods (5)**	
	Bonniewood neighborhood	$ to be determined
	Highlands neighborhood	$ to be determined
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for floodplain encroachment mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for floodplain encroachment mitigation.)		
Total Study Area		**$ to be determined**

7.22 - FLOODPLAINS - REDUCED FLOOD STORAGE CAPACITY MITIGATION

Neighborhoods within 100-year floodplains may experience an increase in downstream runoff due to a decrease in upstream permeable surfaces, resulting in inadequate downstream storage capacity. The same neighborhoods identified in Table 7.11 above may experience reduced flood storage capacity as a result of the Third Runway project. A stormwater management plan will improve flood control due to increases in runoff.

7.23 - FLOODPLAINS - INCREASED FLOW RATE/VOLUME MITIGATION

Neighborhoods within a 100-year floodplain may be impacted by increased upstream runoff from the Airport. The same neighborhoods identified in Table 7.10 above may experience increased stormwater flow rates and volumes as a result of the Third Runway project. The same stormwater management plan previously mentioned would address these impacts.

7.24 - FLOODPLAINS - ADDITIONAL MITIGATION MEASURES

At least 2 months before the start of construction, the Port of Seattle should provide the following:

- Information on the relationship between the 100 and 500-year floodplains, recent storms in the Puget Sound region and the Master Plan Update implementation EIS analysis.
- A copy of the final monitoring plan for evaluating the effectiveness of the Miller Creek and Des Moines Creek relocations.
- Final design information for the Miller Creek and Des Moines Creek relocations including specifications and drawings.

Cumulative Impacts

In the EIS cumulative impacts on water resources during construction associated with Master Plan Update implementation and other projects are not discussed in detail. At least 2 months prior to the start of construction the Port of Seattle should provide for review/approval a more comprehensive cumulative impacts discussion.

7.25 - AESTHETICS AND VISUAL - GROUND SHADOW MITIGATION

Neighborhoods adjacent to the northern, southern, and western edges of the Airport property will be subjected to increased shadows as a result of the 20 MCY of fill material necessary for construction of the Third Runway. These neighborhoods include the East Central and South East neighborhoods (both within the City of Burien). Neighborhoods that are redeveloped also will be mitigated for this impact. Other neighborhoods may require additional remodeling to reduce these aesthetic impacts. A "visual inventory" should be conducted to fully project the extent of these impacts.

7.26 - AESTHETICS AND VISUAL - VISIBILITY OF AIRCRAFT

Neighborhoods underneath or adjacent to flight tracks will view arriving and departing aircraft. To mitigate these impacts, the Airport may modify flight tracks to re-route aircraft over non-residential areas. The measures associated with overflight mitigation and ground shadow mitigation will simultaneously mitigate these areas as well. No further mitigation measures are suggested for these areas.

7.27 - AESTHETICS AND VISUAL - VISIBILITY OF FILL

Neighborhoods adjacent to the western edge of the Airport property will be in the line-of-sight of the 20 MCY of fill material necessary for construction of the Third Runway. Table 7.12 identifies these neighborhoods within the study area.

Table 7.12
Neighborhoods Identified for Fill Visibility Mitigation

City	Area	Amount
Burien	**Neighborhoods (7)**	
	North Central neighborhood	$ to be determined
	North East neighborhood	$ to be determined
	Central neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Des Moines	**Neighborhoods (3)**	
	North Hill neighborhood	$ to be determined
	West Central neighborhood	$ to be determined
	North Central neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for fill visibility mitigation.	$0.0 million
Normandy Park	**Neighborhoods (2)**	
	Bonniewood neighborhood	$ to be determined
	North neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for fill visibility mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for fill visibility mitigation.)		
Total Study Area		**$ to be determined**

Neighborhoods that are redeveloped also will be mitigated for the aesthetics and visual impact. Other neighborhoods may require additional measures to reduce these aesthetic impacts, including reforestation/re-landscaping or improvements to the Airport Landscape Plan.

7.28 - AESTHETICS AND VISUAL - ADDITIONAL MITIGATION MEASURES

Prior to the start of construction, the Port of Seattle should provide the following concerning aesthetic and visual resources.

Color Photographs

Color photographs of pictures taken from the EIS viewpoints and additional viewpoints which show the existing and future conditions. The additional viewpoints should be selected based on discussions with a working group/oversight commission. The selection of viewpoints should consider short-range, medium-range and long-range views. For example, to the west of the Airport the viewpoints might be as follows: short-range, 1/2 mile or less from the Third Runway; medium-range, 1/2 to 1 mile from the Third Runway; and long-range, 1 to 1.5 miles or more from the Third Runway.

Landscape Plans

Landscape plans for the borrow source areas and the Third Runway fill area. These plans should take into consideration the following:

- The City of SeaTac and other appropriate landscape requirements.
- Planting temporary vegetation or a cover crop as construction in various areas is completed or proceeds in order to minimize short term impacts, in particular from erosion and sedimentation.
- The final landscaping should include the use of a variety of native vegetation which require low maintenance; and has a mixture of seedlings and more mature plants in order to avoid a monoculture.

Other Visual Impacts

A cumulative impacts discussion and color photographs, if appropriate, of facilities associated with Master Plan Update implementation and other known proposed projects in the Airport area.

Following construction of the facilities associated with Master Plan Update implementation, the Port of Seattle should provide a landscape maintenance plan. The plan should include a description of the proposed uses of any pesticides such as herbicides and insecticides.

7.29 - OTHER ENVIRONMENTAL IMPACTS

Special Status Species/Habitat Mitigation

Neighborhoods with EIS-identified habitats should be further studied to determine the Third Runway's impact on endangered or threatened species. A preservation and protection plan should be developed for the neighborhoods identified in Table 7.13

Table 7.13
Neighborhoods Identified for Special Status Species/Habitat Mitigation

City	Area	Amount
Burien	**Neighborhoods (5)**	
	Shorewood neighborhood	$ to be determined
	Seahurst Park neighborhood	$ to be determined
	Seahurst neighborhood	$ to be determined
	Lake Burien neighborhood	$ to be determined
	South West neighborhood	$ to be determined
Des Moines	No neighborhoods in Des Moines have been identified for special status species/habitat mitigation.	$0.0 million
Federal Way	No neighborhoods in Federal Way have been identified for special status species/habitat mitigation.	$0.0 million
Normandy Park	No neighborhoods in Normandy Park have been identified for special status species/habitat mitigation.	$0.0 million
Tukwila	**Neighborhoods (1)**	
	Allentown neighborhood	$ to be determined
(No Highline School District or Highline Community Hospital facilities have been identified for special status species/habitat mitigation.)		
Total Study Area		**$ to be determined**

Cultural Resource Mitigation

Neighborhoods with significant cultural resources (architectural, religious, ethnic, etc.) should be further studied to determine the Third Runway's potential impact on these resources. A preservation and protection plan should be developed for the neighborhoods identified in Table 7.14.

Table 7.14
Neighborhoods Identified for Cultural Resource Mitigation

City	Area	Amount
Burien	**Neighborhoods (7)**	
	North East neighborhood	$ to be determined
	Lake Burien neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	South West neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
	South East neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Des Moines	**Neighborhoods (3)**	
	West Central neighborhood	$ to be determined
	Redondo neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for cultural resource mitigation.	$0.0 million
Normandy Park	No neighborhoods in Normandy Park have been identified for cultural resource mitigation.	$0.0 million
Tukwila	No neighborhoods in Tukwila have been identified for cultural resource mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for cultural resource mitigation.)		
Total Study Area		**$ to be determined**

Coastal Zone Mitigation

Neighborhoods adjacent to Puget Sound may be impacted by coastal pollution associated with polluted stormwater runoff or increased sedimentation and erosion associated with the proposed barge/conveyor system. Potential point sources for pollutants should be identified and a pollution control management plan developed for the neighborhoods identified in Table 7.15.

Table 7.15
Neighborhoods Identified for Coastal Zone Mitigation

City	Area	Amount
Burien	**Neighborhoods (4)**	
	Shorewood neighborhood	$ to be determined
	Seahurst Park neighborhood	$ to be determined
	Seahurst neighborhood	$ to be determined
	South West neighborhood	$ to be determined
Des Moines	**Neighborhoods (4)**	
	Zenith neighborhood	$ to be determined
	West Woodmont neighborhood	$ to be determined
	Redondo neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	No neighborhoods in Federal Way have been identified for coastal zone mitigation.	$0.0 million
Normandy Park	**Neighborhoods (3)**	
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	No neighborhoods in Tukwila have been identified for coastal zone mitigation.	$0.0 million
(No Highline School District or Highline Community Hospital facilities have been identified for coastal zone mitigation.)		
Total Study Area		**$ to be determined**

DOT Section 4(F) Resource Mitigation

Neighborhoods with significant open spaces, parks, and recreational areas may be impacted by increased traffic and congestion associated with increased demand at the Airport. These resources should be preserved and protected from potential impacts, or should be relocated and replaced if possible. Table 7.16 identifies the neighborhoods in the study with these resources.

Table 7.16
Neighborhoods Identified for Section 4(f) Mitigation

City	Area	Amount
Burien	**Neighborhoods (5)**	
	Shorewood neighborhood	$ to be determined
	North Central neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	South West neighborhood	$ to be determined
	Gregory Heights neighborhood	$ to be determined
Des Moines	**Neighborhoods (7)**	
	West Central neighborhood	$ to be determined
	North Central neighborhood	$ to be determined
	Zenith neighborhood	$ to be determined
	South Des Moines neighborhood	$ to be determined
	West Woodmont neighborhood	$ to be determined
	Redondo neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
Federal Way	**Neighborhoods (3)**	
	Wildwood neighborhood	$ to be determined
	Easter Lake neighborhood	$ to be determined
	Steel Lake neighborhood	$ to be determined
Normandy Park	**Neighborhoods (5)**	
	North neighborhood	$ to be determined
	Riviera neighborhood	$ to be determined
	East Central neighborhood	$ to be determined
	Arrow Lake neighborhood	$ to be determined
	South neighborhood	$ to be determined
Tukwila	**Neighborhoods (2)**	
	Foster neighborhood	$ to be determined
	McMicken neighborhood	$ to be determined
(No Highline School District or Highline Community Hospital facilities have been identified for Section 4(f) mitigation.)		
Total Study Area		**$ to be determined**

7.30 - OVERSIGHT COMMISSION

Previous references in this Section have mentioned a "working group" or oversight commission" which play a critical role in the mitigation process. Because of the extent of the mitigation measures discussed, a working group or oversight commission should be assembled to interact with the Port of Seattle during Master Plan Update implementation. The group should have permanent staff with technical expertise in airport construction and operation and should be supported by representatives of the various cities around the Airport and citizen groups.

The permanent staff positions should be funded as part of the mitigation agreement and should be separate from Port of Seattle staff.

The working group/oversight commission should be provided documentation related to the mitigation measures discussed here. The group will then evaluate this information, provide the Port of Seattle comments and finally approve the proposed mitigation measures. In order to avoid delays with the proposed activities associated with Master Plan Update implementation, the information should be provided for review at least 30 to 60 days before proceeding with the various activities. Work on the proposed activities cannot proceed without the group's approval of the mitigation measures and related information.

As part of the mitigation measures for the EIS environmental disciplines, the Port of Seattle should provide the working group/oversight commission prior to Master Plan Update implementation, a table of all of the engineering and environmental permits/approvals which are required for construction and operation. In addition, a schedule for obtaining these permits/approvals should be provided. Then, throughout the construction period and until all operating permits/approvals are obtained, monthly permits/approvals status reports will be provided. The mitigation measures specified here should not take the place of the measures discussed in the EIS. They should be used in conjunction with and should supplement the mitigation measures discussed in the EIS.

7.31 - ENVIRONMENTAL IMPACT SUMMARIES

Plates 7.1 through 7.6 summarize the potential environmental impacts for each of the five impacted communities, plus the Highline School District and Highline Community Hospital. The impact, mitigation measure, and costs are identified for each neighborhood. The following conventions should be noted when reviewing these Plates:

- **"- - -"** - Indicates that there is no impact identified for this neighborhood.
- **"$ TBD"** - Indicates that the mitigation costs are yet to be determined. Not enough information was available during this study to determine these costs.
- **"$0.0 M"** - Indicates that there are no mitigation costs for this neighborhood.
- **"Mitigated by . . . measures"** - Indicates that other mitigation measures simultaneously mitigate this neighborhood for multiple impact types.
- **"See . . . matrix"** - (Appears only in the Public Facility matrix) Indicates that these impacts are addressed by measures delineated in another City/neighborhood matrix.
- **"Outside Study Area"** - (Appears only in the Public Facility matrix) Indicates that only impacts to the school/hospital building are delineated. Analysis of other impacts are outside the scope of this study.

ENVIRONMENTAL IMPACT MATRIX - CITY OF BURIEN

PLATE 7.1

Neighborhood		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air Emissions (Aircraft)	CO Emissions (Vehicles)	HC Emissions (Vehicles)	Air Toxics	Fugitive Emissions	Point Source	Runoff Volume	Erosion & Sediment	Spills	Aquifer Recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced Flood Storage Capacity	Increased Flow Rate & Volume	Ground Shadow	Visibility (Aircraft)	Visibility (Fill)	Special Status Species/ Hab.	Cult-ural Res's.	Coast. Zone	DOT Sec. 4(f) Res.
Shorewood	*Impact*	---	---	Sound exposure	---	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	E/T loss	---	Pollu-tion	Park loss
	Mitigation	---	---	Insulation/ easement	---	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	Preser-vation	---	Control source	Avoid/ replace
(601 acres)	*Cost*	---	---	$22.5 M	---	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	$ TBD	---	$ TBD	$ TBD
North Central	*Impact*	---	Topo. 400' w/in 5 mi.	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	Views of fill	---	---	---	Park loss
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	Screening/ landscap.	---	---	---	Avoid/ replace
(488 acres)	*Cost*	---	$18.3 M	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	$ TBD	---	---	---	$ TBD
North East	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	Flooding	Slides	Spills	Contam./ destruc.	Pollution	Loss of wetlands	Flooding	Flooding	Flooding	---	Mitigated	Views of fill	---	Loss	---	---
	Mitigation	Acquire/ redevelop	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip	Control plan	FBO control	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	Relocate/ replace	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	by TA	Screening/ landscap.	---	Avoid/ replace	---	---
(707 acres)	*Cost*	$537.0 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	measures	$ TBD	---	$ TBD	---	---
Seahurst Park	*Impact*	---	---	---	---	Air pollution	---	---	---	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	---	---	E/T loss	---	Pollu-tion	---
	Mitigation	---	---	---	---	Op's and equipment	---	---	---	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	---	---	Preser-vation	---	Control source	---
(166 acres)	*Cost*	---	---	---	---	$0.0 M	---	---	---	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	---	---	$ TBD	---	$ TBD	---
Seahurst	*Impact*	---	---	---	---	Air pollution	Mitigated	---	---	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	---	---	E/T loss	---	Pollu-tion	---
	Mitigation	---	---	---	---	Op's and equipment	by LOS	---	---	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	---	---	Preser-vation	---	Control source	---
(393 acres)	*Cost*	---	---	---	---	$0.0 M	measures	---	---	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	---	---	$ TBD	---	$ TBD	---
Central	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	Mitigated	Mitigated	---	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	Views of fill	---	---	---	---
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	by LOS	by LOS	---	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	Screening/ landscap.	---	---	---	---
(156 acres)	*Cost*	---	$5.8 M	---	measures	$0.0 M	measures	measures	---	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	$ TBD	---	---	---	---
Lake Burien	*Impact*	---	---	---	---	Air pollution	---	---	---	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	---	---	E/T loss	Loss	---	---
	Mitigation	---	---	---	---	Op's and equipment	---	---	---	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	---	---	Preser-vation	Avoid/ replace	---	---
(162 acres)	*Cost*	---	---	---	---	$0.0 M	---	---	---	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	---	---	$ TBD	$ TBD	---	---
East Central	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	Flooding	Slides	Spills	Contam./ destruc.	Pollution	Loss of wetlands	Flooding	Flooding	Flooding	Fill shadow	Mitigated	Mitigated	---	Loss	---	Park loss
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	Control plan	FBO control	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	Relocate/ replace	Manage-ment plan	Manage-ment plan	Manage-ment plan	Screening/ landscap.	by TA	by Ground Shadow measures	---	Avoid/ replace	---	Avoid/ replace
(254 acres)	*Cost*	$9.5 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	measures	measures	---	$ TBD	---	$ TBD
South West	*Impact*	---	---	---	---	Air pollution	---	---	---	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	---	---	E/T loss	Loss	Pollu-tion	Park loss
	Mitigation	---	---	---	---	Op's and equipment	---	---	---	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	---	---	Preser-vation	Avoid/ replace	Control source	Avoid/ replace
(365 acres)	*Cost*	---	---	---	---	$0.0 M	---	---	---	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	---	---	$ TBD	$ TBD	$ TBD	$ TBD
Gregory Heights	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	---	---	---	---	---	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	Mitigated	Views of fill	---	Loss	---	Park loss
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	---	---	---	---	---	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	by TA	Screening/ landscap.	---	Avoid/ replace	---	Avoid/ replace
(574 acres)	*Cost*	---	$21.5 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	measures	$ TBD	---	$ TBD	---	$ TBD
South East	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	Flooding	Slides	Spills	Contam./ destruc.	Pollution	Loss of wetlands	Flooding	Flooding	Flooding	Fill shadow	Mitigated	Mitigated	---	Loss	---	---
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	Control plan	FBO control	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	Relocate/ replace	Manage-ment plan	Manage-ment plan	Manage-ment plan	Screening/ landscap.	by TA	by Ground Shadow measures	---	Avoid/ replace	---	---
(268 acres)	*Cost*	$10.0 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	measures	measures	---	$ TBD	---	---
Downtown	*Impact*	60 contour	Mitigated	---	Mitigated	Air pollution	Mitigated	Mitigated	---	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	Views of fill	---	Loss	---	---
	Mitigation	Insulation/ easement	by LDN	---	by LDN	Op's and equipment	by LOS	by LOS	---	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	Screening/ landscap.	---	Avoid/ replace	---	---
(308 acres)	*Cost*	$12.0 M	measures	---	measures	$0.0 M	measures	measures	---	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	$ TBD	---	$ TBD	---	---
Total (4,442 ac.)	$636.6 M plus TBD	$568.5 M	$45.6 M	$22.5 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD

ENVIRONMENTAL IMPACT MATRIX - CITY OF DES MOINES

PLATE 7.2

NEIGHBORHOOD		NOISE & VIBRATION				AIR QUALITY						SURFACE WATER QUALITY/HYDROLOGY			GROUND WATER QUALITY/HYDROLOGY		WETLANDS	FLOODPLAINS			AESTHETICS AND VISUAL			OTHER			
NAME	MEASURES	LDN	SEL	OVER-FLIGHTS (TA)	VIBRATION	AIR EMISSIONS (AIRCRAFT)	CO EMISSIONS (VEHICLES)	HC EMISSIONS (VEHICLES)	AIR TOXICS	FUGITIVE EMISSIONS	POINT SOURCE	RUNOFF VOLUME	EROSION & SEDIMENT	SPILLS	AQUIFER RECHARGE	CONTAM-INATION	DESTRUC-TION	ENCROACH-MENT	REDUCED FLOOD STORAGE CAPACITY	INCREASED FLOW RATE & VOLUME	GROUND SHADOW	VISIBILITY (AIRCRAFT)	VISIBILITY (FILL)	SPECIAL STATUS SPECIES/ HAB.	CULT-URAL RES's.	COAST. ZONE	DOT SEC. 4(F) RES.
North Hill	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	Mitigated	Views of fill	---	---	---	---
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	Dust con-trol plan	FBO controls	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	by TA	Screening/ landscap.	---	---	---	---
(623 acres)	*Cost*	$23.4 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	measures	$ TBD	---	---	---	---
West Central	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	Mitigated	Views of fill	---	Loss	---	Park loss
	Mitigation	Acquire/ redevelop	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	Dust con-trol plan	FBO controls	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	by TA	Screening/ landscap.	---	Avoid/ replace	---	Avoid/ replace
(479 acres)	*Cost*	$364.9 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	measures	$ TBD	---	$ TBD	---	$ TBD
North Central	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Air pollution	---	Mitigated	Air pollution	Dust	Pollution	---	Slides	Spills	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	Views of fill	---	---	---	Park loss
	Mitigation	Acquire/ redevelop	by LDN	by LDN	by LDN	Op's and equipment	---	by LOS	Op's and equip.	Dust con-trol plan	FBO controls	---	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	Screening/ landscap.	---	---	---	Avoid/ replace
(241 acres)	*Cost*	$183.2 M	measures	measures	measures	$0.0 M	---	measures	$0.0 M	$0.0 M	$ TBD	---	$ TBD	$ TBD	$ TBD	$ TBD	---	---	---	---	---	measures	$ TBD	---	---	---	$ TBD
East Central	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	Acquire/ redevelop	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	Dust con-trol plan	FBO controls	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	---
(626 acres)	*Cost*	$475.8 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	---
Zenith	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	Pollu-tion	Park loss
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	Source control	Avoid/ replace
(550 acres)	*Cost*	$20.6 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	$ TBD	$ TBD
South Des Moines	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	Park loss
	Mitigation	Acquire/ redevelop	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	Avoid/ replace
(492 acres)	*Cost*	$373.9 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	$ TBD
West Woodmont	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	Pollu-tion	Park loss
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	Source control	Avoid/ replace
(430 acres)	*Cost*	$16.1 M	measures	measures	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	$ TBD	$ TBD
East Woodmont	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	---
(306 acres)	*Cost*	$11.5 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	---
Redondo	*Impact*	---	Topo. 400' w/in 4 mi.	Mitigated	Mitigated	Air pollution	---	---	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	Loss	Pollu-tion	Park loss
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	---	---	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	Avoid/ replace	Source control	Avoid/ replace
(212 acres)	*Cost*	---	$7.9 M	measures	measures	$0.0 M	---	---	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	$ TBD	$ TBD	$ TBD
Downtown	*Impact*	---	Topo. 400' w/in 5 mi.	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	Dust	Pollution	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	Loss	Pollu-tion	Park loss
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	Dust con-trol plan	FBO controls	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	Avoid/ replace	Source control	Avoid/ replace
(108 acres)	*Cost*	---	$4.1 M	measures	measures	$0.0 M	measures	measures	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	$ TBD	$ TBD	$ TBD
Total (4,067 ac.)		$1,481.4 M plus TBD	$1,469.4 M	$12.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$TBD	$TBD	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$0.0 M	$ TBD	$ 0.0 M	$ TBD	$ TBD	$ TBD

ENVIRONMENTAL IMPACT MATRIX - CITY OF FEDERAL WAY

PLATE 7.3

Neighborhood		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air emissions (aircraft)	CO emissions (vehicles)	HC emissions (vehicles)	Air toxics	Fugitive emissions	Point source	Runoff volume	Erosion & sediment	Spills	Aquifer recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced flood storage capacity	Increased flow rate & volume	Ground shadow	Visibility (aircraft)	Visibility (fill)	Special status species/ hab.	Cult-ural res's.	Coast. zone	DOT Sec. 4(f) res.
Star Lake	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(531 acres)	*Cost*	$19.5 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Wildwood	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	Park loss
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	Avoid/ replace
(553 acres)	*Cost*	$20.7 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	$ TBD
Marine Hills	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(529 acres)	*Cost*	---	---	$19.8 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Mar-Cheri	*Impact*	---	---	Overflight exposure	Mitigated	Air pollution	---	---	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	---	---	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(311 acres)	*Cost*	---	---	$0.0 M	measures	$0.0 M	---	---	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Dash Point	*Impact*	---	---	Overflight exposure	Mitigated	Air pollution	---	---	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	---	---	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(826 acres)	*Cost*	---	---	$ 0.0 M	measures	$0.0 M	---	---	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Lakota	*Impact*	---	---	Overflight exposure	Mitigated	Air pollution	Mitigated	---	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	by LOS	---	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(949 acres)	*Cost*	---	---	$0.0 M	measures	$0.0 M	measures	---	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Mirror Lake	*Impact*	---	---	Overflight exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(713 acres)	*Cost*	---	---	$0.0 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Easter Lake	*Impact*	---	---	Overflight exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	Park loss
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	Avoid/ replace
(729 acres)	*Cost*	---	---	$0.0 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	$ TBD
Steel Lake	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	Park loss
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	Avoid/ replace
(347 acres)	*Cost*	---	---	$13.0 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	$ TBD
Twin Lakes	*Impact*	---	---	Overflight exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(1,118 acres)	*Cost*	---	---	$0.0 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---

ENVIRONMENTAL IMPACT MATRIX - CITY OF FEDERAL WAY (continued)

PLATE 7.3 (continued)

Neighborhood		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air Emissions (Aircraft)	CO Emissions (Vehicles)	HC Emissions (Vehicles)	Air Toxics	Fugitive Emissions	Point Source	Runoff Volume	Erosion & Sediment	Spills	Aquifer Recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced Flood Storage Capacity	Increased Flow Rate & Volume	Ground Shadow	Visibility (Aircraft)	Visibility (Fill)	Special Status Species/ Hab.	Cult-ural Res's.	Coast. Zone	DOT Sec. 4(f) Res.
West Campus	*Impact*	---	---	Overflight exposures	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Modify flight track	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(848 acres)	*Cost*	---	---	$0.0 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
First Avenue	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(546 acres)	*Cost*	---	---	$20.5 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Kitts Corner North	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(299 acres)	*Cost*	---	---	$11.2 M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
City Center	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(430 acres)	*Cost*	---	---	$16.1M	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Total (8,719 ac.)	$148.1 M plus TBD	$40.2 M	$0.0 M	$107.9 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ 0.0 M	$ 0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$0.0 M	$ TBD	$ 0.0 M	$0.0 M	$0.0 M	$ TBD

ENVIRONMENTAL IMPACT MATRIX - CITY OF TUKWILA

PLATE 7.5

Neighborhood		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air emissions (aircraft)	CO emissions (vehicles)	HC emissions (vehicles)	Air toxics	Fugitive emissions	Point source	Runoff volume	Erosion & sediment	Spills	Aquifer recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced flood storage capacity	Increased flow rate & volume	Ground shadow	Visibility (aircraft)	Visibility (fill)	Special status species/ hab.	Cult-ural res's.	Coast. zone	DOT Sec. 4(f) res.
Ryan	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(114 acres)	*Cost*	---	---	$4.3 M	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Allentown	*Impact*	---	Topo. 400' w/in 5 mi.	Mitigated	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	E/T loss	---	---	---
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	Preser-vation	---	---	---
(346 acres)	*Cost*	---	$13.0 M	measures	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	$ TBD	---	---	---
Cascade View	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(303 acres)	*Cost*	---	$11.4 M	---	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Foster	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Park loss
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Avoid/ replace
(485 acres)	*Cost*	---	$18.2 M	---	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD
Thorndyke	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(420 acres)	*Cost*	---	$15.7 M	---	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tukwila Hill	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(857 acres)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
McMicken	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Park loss
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Avoid/ replace
(461 acres)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD
M.I.C.	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(1,083 ac.)	*Cost*	$40.6 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Riverton	*Impact*	---	Topo. 400' w/in 5 mi.	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(276 acres)	*Cost*	---	$10.3 M	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
CBD	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(1,095 ac.)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tukwila Valley South	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Park loss
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Avoid/ replace
(367 acres)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD
Total (5,807 ac.)		$113.5 M plus TBD	$40.6 M	$68.6 M	$4.3 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$0.0 M	$0.0 M	$ TBD

ENVIRONMENTAL IMPACT MATRIX - CITY OF TUKWILA

PLATE 7.5

NEIGHBORHOOD		NOISE & VIBRATION				AIR QUALITY						SURFACE WATER QUALITY/HYDROLOGY			GROUND WATER QUALITY/HYDROLOGY		WETLANDS	FLOODPLAINS			AESTHETICS AND VISUAL			OTHER			
NAME	MEASURES	LDN	SEL	OVER-FLIGHTS (TA)	VIBRATION	AIR EMISSIONS (AIRCRAFT)	CO EMISSIONS (VEHICLES)	HC EMISSIONS (VEHICLES)	AIR TOXICS	FUGITIVE EMISSIONS	POINT SOURCE	RUNOFF VOLUME	EROSION & SEDIMENT	SPILLS	AQUIFER RECHARGE	CONTAM-INATION	DESTRUC-TION	ENCROACH-MENT	REDUCED FLOOD STORAGE CAPACITY	INCREASED FLOW RATE & VOLUME	GROUND SHADOW	VISIBILITY (AIRCRAFT)	VISIBILITY (FILL)	SPECIAL STATUS SPECIES/ HAB.	CULT-URAL RES'S.	COAST. ZONE	DOT SEC. 4(F) RES.
Ryan	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(114 acres)	*Cost*	---	---	$4.3 M	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Allentown	*Impact*	---	Topo. 400' w/in 5 mi.	Mitigated	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	E/T loss	---	---	---
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	Preser-vation	---	---	---
(346 acres)	*Cost*	---	$13.0 M	measures	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	$ TBD	---	---	---
Cascade View	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(303 acres)	*Cost*	---	$11.4 M	---	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Foster	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Park loss
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Avoid/ replace
(485 acres)	*Cost*	---	$18.2 M	---	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD
Thorndyke	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(420 acres)	*Cost*	---	$15.7 M	---	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tukwila Hill	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(857 acres)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
McMicken	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Park loss
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Avoid/ replace
(461 acres)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD
M.I.C.	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(1,083 ac.)	*Cost*	$40.6 M	measures	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
Riverton	*Impact*	---	Topo. 400' w/in 5 mi.	Mitigated	Mitigated	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	Insulation/ easement	by SEL	by SEL	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	by TA	---	---	---	---	---
(276 acres)	*Cost*	---	$10.3 M	measures	measures	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	measures	---	---	---	---	---
CBD	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
(1,095 ac.)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tukwila Valley South	*Impact*	---	---	---	---	Air pollution	Mitigated	Mitigated	Air pollution	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Park loss
	Mitigation	---	---	---	---	Op's and equipment	by LOS	by LOS	Op's and equip.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Avoid/ replace
(367 acres)	*Cost*	---	---	---	---	$0.0 M	measures	measures	$0.0 M	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD
Total (5,807 ac.)	$113.5 M plus TBD	$40.6 M	$68.6 M	$4.3 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$0.0 M	$0.0 M	$ TBD

ENVIRONMENTAL IMPACT MATRIX - CITY OF NORMANDY PARK

PLATE 7.4

Neighborhood		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air emissions (aircraft)	CO emissions (vehicles)	HC emissions (vehicles)	Air toxics	Fugitive emissions	Point source	Runoff volume	Erosion & sediment	Spills	Aquifer recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced flood storage capacity	Increased flow rate & volume	Ground shadow	Visibility (aircraft)	Visibility (fill)	Special status species/ hab.	Cult-ural res's.	Coast. zone	DOT Sec. 4(f) res.
Bonniewood	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	---	Mitigated	---	---	---	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	---	Views of fill	---	---	---	---
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	---	by LOS	---	---	---	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	---	Screening/ landscap.	---	---	---	---
(41 acres)	*Cost*	---	$1.5 M	---	measures	$0.0 M	---	measures	---	---	---	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	---	$ TBD	---	---	---	---
Highlands	*Impact*	---	---	---	---	Air pollution	---	---	---	---	---	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	---	---	---	---	---	---
	Mitigation	---	---	---	---	Op's and equipment	---	---	---	---	---	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	---	---	---	---	---	---
(81 acres)	*Cost*	---	---	---	---	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	---	---	---	---	---	---
North	*Impact*	---	Topo. 400' w/in 5 mi.	---	Mitigated	Air pollution	---	Mitigated	---	---	---	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	---	Views of fill	---	---	Pollu-tion	Park loss
	Mitigation	---	Insulation/ easement	---	by SEL	Op's and equipment	---	by LOS	---	---	---	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	---	Screening/ landscap.	---	---	Control source	Avoid/ replace
(348 acres)	*Cost*	---	$13.0 M	---	measures	$0.0 M	---	measures	---	---	---	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	---	$ TBD	---	---	$ TBD	$ TBD
Riviera	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	Mitigated	---	---	---	Pollu-tion	Park loss
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	by TA	---	---	---	Control source	Avoid/ replace
(240 acres)	*Cost*	---	---	$9.0 M	measures	$0.0 M	---	measures	$0.0 M	---	---	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	measures	---	---	---	$ TBD	$ TBD
Manhattan	*Impact*	60 contour	---	Mitigated	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	Insulation/ easement	---	by LDN	by LDN	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	---
(90 acres)	*Cost*	$3.4 M	---	mesures	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	---
East Central	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	Park loss
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	Avoid/ replace
(248 acres)	*Cost*	---	---	$9.3 M	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	$ TBD
Normandy Province	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	---
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	---
(39 acres)	*Cost*	---	---	$1.5 M	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	---
Arrow Lake	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	---	---	---	Contam./ destruc.	Pollution	---	---	---	---	---	Mitigated	---	---	---	---	Park loss
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	---	---	---	Manage-ment plan	Manage-ment plan	---	---	---	---	---	by TA	---	---	---	---	Avoid/ replace
(29 acres)	*Cost*	---	---	$1.1 M	measures	$0.0 M	---	measures	$0.0 M	---	---	---	---	---	$ TBD	$ TBD	---	---	---	---	---	measures	---	---	---	---	$ TBD
South	*Impact*	---	---	Sound exposure	Mitigated	Air pollution	---	Mitigated	Air pollution	---	---	Flooding	Slides	Spills	Contam./ destruc.	Pollution	---	Flooding	Flooding	Flooding	---	Mitigated	---	E/T loss	Loss	Pollu-tion	Park loss
	Mitigation	---	---	Insulation/ easement	by TA	Op's and equipment	---	by LOS	Op's and equip.	---	---	Manage-ment plan	Manage-ment plan	On-site contain.	Manage-ment plan	Manage-ment plan	---	Manage-ment plan	Manage-ment plan	Manage-ment plan	---	by TA	---	Preser-vation	Avoid/ replace	Control source	Avoid/ replace
(454 acres)	*Cost*	---	---	$17.0 M	measures	$0.0 M	---	measures	$0.0 M	---	---	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	---	$ TBD	$ TBD	$ TBD	---	measures	---	$ TBD	$ TBD	$ TBD	$ TBD
Total (1,570 ac.)	$55.8 M plus TBD	$3.4 M	$14.5 M	$37.9 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$0.0 M	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD

ENVIRONMENTAL IMPACT MATRIX - PUBLIC FACILITIES

PLATE 7.6

PUBLIC FACILITY		NOISE & VIBRATION				AIR QUALITY						SURFACE WATER QUALITY/HYDROLOGY			GROUND WATER QUALITY/HYDROLOGY		WETLANDS	FLOODPLAINS			AESTHETICS AND VISUAL			OTHER			
NAME	MEASURES	LDN	SEL	OVER-FLIGHTS (TA)	VIBRATION	AIR EMISSIONS (AIRCRAFT)	CO EMISSIONS (VEHICLES)	HC EMISSIONS (VEHICLES)	AIR TOXICS	FUGITIVE EMISSIONS	POINT SOURCE	RUNOFF VOLUME	EROSION & SEDIMENT	SPILLS	AQUIFER RECHARGE	CONTAM-INATION	DESTRUC-TION	ENCROACH-MENT	REDUCED FLOOD STORAGE CAPACITY	INCREASED FLOW RATE & VOLUME	GROUND SHADOW	VISIBILITY (AIRCRAFT)	VISIBILITY (FILL)	SPECIAL STATUS SPECIES/ HAB.	CULT-URAL RES'S.	COAST. ZONE	DOT SEC. 4(F) RES.
HIGHLINE SCHOOL/HOSPITAL FACILITIES IN CITY OF BURIEN																											
Highline Community Hospital (Gregory Heights)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Gregory Heights (Plate 7.1)	---	---	---	---	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Greg. Heights (Plate 7.1)	---	See Greg. Heights (Plate 7.1)
	Mitigation	Insulation/ easement					---	---	---	---	---						---				---			---		---	
	Cost	$ TBD					---	---	---	---	---						---				---			---		---	
Gregory Heights Elementary School (Gregory Heights)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Gregory Heights (Plate 7.1)	---	---	---	---	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Greg. Heights (Plate 7.1)	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Greg. Heights (Plate 7.1)	---	See Greg. Heights (Plate 7.1)
	Mitigation	Insulation/ easement					---	---	---	---	---						---				---			---		---	
	Cost	$ TBD					---	---	---	---	---						---				---			---		---	
Sylvester Middle School (Gregory Heights)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Gregory Heights (Plate 7.1)	---	---	---	---	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Gregory Heights (Plate 7.1)	See Gregory Heights (Plate 7.1)	---	See Greg. Heights (Plate 7.1)	---	See Greg. Heights (Plate 7.1)
	Mitigation	Insulation/ easement					---	---	---	---	---						---				---			---		---	
	Cost	$ TBD					---	---	---	---	---						---				---			---		---	
Hazel Valley Elementary School (Downtown)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Down-town (Plate 7.1)	See Down-town (Plate 7.1)	See Down-town (Plate 7.1)	---	---	---	---	---	---	See Down-town (Plate 7.1)	See Down-town (Plate 7.1)	---	---	---	---	---	See Down-town (Plate 7.1)	See Down-town (Plate 7.1)	---	See Down-town (Plate 7.1)	---	---
	Mitigation	Insulation/ easement							---	---	---						---							---		---	
	Cost	$ TBD							---	---	---						---							---		---	
Salmon Creek Elementary School (North Central)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See North Central (Plate 7.1)	See North Central (Plate 7.1)	See North Central (Plate 7.1)	See North Central (Plate 7.1)	---	---	---	---	---	See North Central (Plate 7.1)	See North Central (Plate 7.1)	---	---	---	---	---	See North Central (Plate 7.1)	See North Central (Plate 7.1)	---	---	---	See North Central (Plate 7.1)
	Mitigation	Insulation/ easement								---	---						---							---		---	
	Cost	$ TBD								---	---						---							---		---	
Seahurst Elementary School (Seahurst)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Seahurst (Plate 7.1)	See Seahurst (Plate 7.1)	---	---	---	---	---	---	---	See Seahurst (Plate 7.1)	See Seahurst (Plate 7.1)	---	---	---	---	---	---	---	---	See Sea-hurst (Plate 7.1)	---	See Sea-hurst (Plate 7.1)
	Mitigation	Insulation/ easement						---	---	---	---						---							---		---	
	Cost	$ TBD						---	---	---	---						---							---		---	
Shorewood Elementary School (Shore-wood)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Shore-wood (Plate 7.1)	---	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)	---	---	---	---	---	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)	---	---	---	---	---	See Shore-wood (Plate 7.1)	---	See Shore-wood (Plate 7.1)	---	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)
	Mitigation	Insulation/ easement					---			---	---						---							---			
	Cost	$ TBD					---			---	---						---							---			
Marine Tech Lab. (Shore-wood)	*Impact*	55 to 60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See Shore-wood (Plate 7.1)	---	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)	---	---	---	---	---	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)	---	---	---	---	---	See Shore-wood (Plate 7.1)	---	See Shore-wood (Plate 7.1)	---	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)	See Shore-wood (Plate 7.1)
	Mitigation	Insulation/ easement					---			---	---						---							---			
	Cost	$ TBD					---			---	---						---							---			
Cedarhurst Elementary School (North East)	*Impact*	65 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	See North East (Plate 7.1)	---	See North East (Plate 7.1)	See North East (Plate 7.1)	---	See North East (Plate 7.1)	---	---
	Mitigation	Replace/ relocate																			---			---		---	---
	Cost	$ TBD																			---			---		---	---
Sunnydale Elementary School (East Central)	*Impact*	70 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	---	See East Central (Plate 7.1)	---	See East Central (Plate 7.1)
	Mitigation	Replace/ relocate																						---		---	
	Cost	$ TBD																						---		---	
Highline High School (East Central)	*Impact*	60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	See East Central (Plate 7.1)	---	See East Central (Plate 7.1)	---	See East Central (Plate 7.1)
	Mitigation	Insulation/ easement																						---		---	
	Cost	$ TBD																						---		---	
HIGHLINE SCHOOL/HOSPITAL FACILITIES IN CITY OF DES MOINES																											
Des Moines Elementary School (West Central)	*Impact*	60 contour	Mitigated by LDN measures	Mitigated by LDN measures	Mitigated by LDN measures	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)
	Mitigation	Insulation/ easement															---							---		---	
	Cost	$ TBD															---							---		---	

ENVIRONMENTAL IMPACT MATRIX - PUBLIC FACILITIES (continued)

Public Facility		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air Emissions (Aircraft)	CO Emissions (Vehicles)	HC Emissions (Vehicles)	Air Toxics	Fugitive Emissions	Point Source	Runoff Volume	Erosion & Sediment	Spills	Aquifer Recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced Flood Storage Capacity	Increased Flow Rate & Volume	Ground Shadow	Visibility (Aircraft)	Visibility (Fill)	Special Status Species/ Hab.	Cult-ural Res's.	Coast. Zone	DOT Sec. 4(f) Res.
Highline School/Hospital Facilities in City of Des Moines (continued)																											
Olympic Elementary School	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)	See West Central (Plate 7.2)	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)	---	See West Central (Plate 7.2)
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN												---				---			---			
(West Central)	*Cost*	$ TBD	measures	measures	measures												---				---			---			
Midway Elementary School	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	---	---	---	See East Central (Plate 7.2)	See East Central (Plate 7.2)	---	---	---	---	---	See East Central (Plate 7.2)	---	---	---	---	---
	Mitigation	Replace/ relocate	by LDN	by LDN	by LDN							---	---	---			---	---	---	---	---		---	---	---	---	---
(East Central)	*Cost*	$ TBD	measures	measures	measures							---	---	---			---	---	---	---	---		---	---	---	---	---
Pacific Middle School	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	---	---	---	See East Central (Plate 7.2)	See East Central (Plate 7.2)	---	---	---	---	---	See East Central (Plate 7.2)	---	---	---	---	---
	Mitigation	Replace/ relocate	by LDN	by LDN	by LDN							---	---	---			---	---	---	---	---		---	---	---	---	---
(East Central)	*Cost*	$ TBD	measures	measures	measures							---	---	---			---	---	---	---	---		---	---	---	---	---
Mount Rainier High School	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	See East Central (Plate 7.2)	---	---	---	See East Central (Plate 7.2)	See East Central (Plate 7.2)	---	---	---	---	---	See East Central (Plate 7.2)	---	---	---	---	---
	Mitigation	Replace/ relocate	by LDN	by LDN	by LDN							---	---	---			---	---	---	---	---		---	---	---	---	---
(East Central)	*Cost*	$ TBD	measures	measures	measures							---	---	---			---	---	---	---	---		---	---	---	---	---
North Hill Elementary School	*Impact*	60 contour	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	---	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	---	See North Hill (Plate 7.2)	See North Hill (Plate 7.2)	---	---	---	---
	Mitigation	Insulation/ easement															---				---			---	---	---	---
(North Hill)	*Cost*	$ TBD															---				---			---	---	---	---
Parkside Elementary School	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	See South Des Moines (Plate 7.2)	See South Des Moines (Plate 7.2)	See South Des Moines (Plate 7.2)	See South D M (Plate 7.2)	---	---	---	---	---	See South Des Moines (Plate 7.2)	See South Des Moines (Plate 7.2)	---	---	---	---	---	See South Des Moines (Plate 7.2)	---	---	---	---	See South D M (Plate 7.2)
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN					---	---	---	---	---			---	---	---	---	---		---	---	---	---	
(South Des Moines)	*Cost*	$ TBD	measures	measures	measures					---	---	---	---	---			---	---	---	---	---		---	---	---	---	
Highline School/Hospital Facilities in City of Normandy Park																											
Marvista Elementary School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	See South	---	See South	See South	---	---	See South	See South	See South	See South	See South	---	See South	See South	See South	---	See South	---	See South	See South	See South	See South
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN		---			---	---						---				---		---				
(South)	*Cost*	$ TBD	measures	measures	measures	(Plate 7.4)	---	(Plate 7.4)	(Plate 7.4)	---	---	(Plate 7.4)	(Plate 7.4)	(Plate 7.4)	(Plate 7.4)	(Plate 7.4)	---	(Plate 7.4)	(Plate 7.4)	(Plate 7.4)	---	(Plate 7.4)	---	(Plate 7.4)	(Plate 7.4)	(Plate 7.4)	(Plate 7.4)
Highline School/Hospital Facilities in City of SeaTac (outside study area)																											
Bow Lake Elementary School	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
(SeaTac)	*Cost*	$ TBD	measures	measures	measures																						
Madrona Elementary School	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
(SeaTac)	*Cost*	$ TBD	measures	measures	measures																						
McMicken Heights Elementary School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
(SeaTac)	*Cost*	$ TBD	measures	measures	measures																						
Valley View Elementary School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
(SeaTac)	*Cost*	$ TBD	measures	measures	measures																						
Chinook Middle School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
(SeaTac)	*Cost*	$ TBD	measures	measures	measures																						

ENVIRONMENTAL IMPACT MATRIX - PUBLIC FACILITIES (continued)

PLATE 7.6 (continued)

Public Facility		Noise & Vibration				Air Quality						Surface Water Quality/Hydrology			Ground Water Quality/Hydrology		Wetlands	Floodplains			Aesthetics and Visual			Other			
Name	Measures	LDN	SEL	Over-Flights (TA)	Vibration	Air Emissions (Aircraft)	CO Emissions (Vehicles)	HC Emissions (Vehicles)	Air Toxics	Fugitive Emissions	Point Source	Runoff Volume	Erosion & Sediment	Spills	Aquifer Recharge	Contam-ination	Destruc-tion	Encroach-ment	Reduced Flood Storage Capacity	Increased Flow Rate & Volume	Ground Shadow	Visibility (Aircraft)	Visibility (Fill)	Special Status Species/ Hab.	Cult-ural Res's.	Coast. Zone	DOT Sec. 4(f) Res.
Highline School/Hospital Facilities in City of SeaTac (continued)																											
Tyee High School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(SeaTac)																											
Sea-Tac Occupa-tional Skill	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(SeaTac)																											
Highline School/Hospital Facilities in City of Seattle (outside study area)																											
Hilltop Elementary School	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(Seattle)																											
Mount View Elementary School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(Seattle)																											
Riverton Heights Elementary School	*Impact*	60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(Seattle)																											
Southern Heights Elementary School	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Replace/ relocate	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(Seattle)																											
Cascade Middle School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(Seattle)																											
Evergreen High School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(Seattle)																											
Highline School/Hospital Facilities in Unincorporated King County (outside study area)																											
Beverly Park Elementary School	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Replace/ relocate	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(County)																											
White Center Elementary School	*Impact*	55 to 60 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Insulation/ easement	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(County)																											
Satellite Alternate High School	*Impact*	65 contour	Mitigated	Mitigated	Mitigated	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation	Replace/ relocate	by LDN	by LDN	by LDN																						
	Cost	$ TBD	measures	measures	measures																						
(County)																											
Total		$ TBD	$ TBD	$0.0 M	$0.0 M	$0.0 M																					

SECTION 8

POTENTIAL TRANSPORTATION IMPACTS AND MITIGATION

SECTION 8
POTENTIAL TRANSPORTATION IMPACTS AND MITIGATION

8.01 - INTRODUCTION

As a result of construction of the Third Runway, there are two general areas of impact to the existing roadway network in the study area:

- Congestion on the network; and,
- Physical damage to the network.

These will occur over two periods of time:

- During construction of the Third Runway, projected in the EIS to be from 1997 to 2000; and,

- After construction of the Third Runway in the period from 2000 to 2020 when the full proposed Master Plan is implemented.

The transportation impacts and mitigation approach taken was to initially determine and list those measurable factors that would enable an impact analysis based upon a reasonable set of data as opposed to a qualitative approach which would be exposed to more opinion rather than reasonableness.

The second step was to assess each measurable factor against an established roadway network in the study area comprised of the freeways, principal arterials, and minor arterials. This functional system will carry the bulk of the Airport-related traffic and is shown in Figure 8.01.

The next step taken was to make a reasoned attempt to identify "types" of improvements to this network that would address the impact factors identified, but which could be implemented in a corridor or areawide approach that would address many impacts with a minimum of cost. The key component was the development of a unit-cost approach for each type of improvement that could be applied on a corridor basis.

Finally, the type of improvement needed to mitigate the identified impacts was determined, the unit-cost for the improvement was applied to the impacted network, and mitigation costs were summarized by City and neighborhood.

Of course, the full cost of mitigation of traffic and transportation impacts is not attributable to construction of the Third Runway or overall Airport operations. The equitable distribution or *pro rata* share of these costs has not yet been determined. A cost-allocation model must be developed to determine the *pro rata* share and should be based upon a comprehensive origin-destination study.

Since the EIS evaluated only those intersections immediately surrounding the Airport, it became necessary to establish a roadway network that potentially would be impacted within the study area. This network was developed using a functional system of roadways that would reasonably carry the bulk of the traffic during and after construction. These roadways were defined as the freeways and principal arterials. However, during the construction phase, if the "trucking only" alternative is selected for the haul of 20 MCY of fill material, significant diversion off the freeway system to the principal arterials is expected. Because these principal arterials are currently operating with high traffic volumes, further diversion to the local minor arterials is projected. therefore, the selected roadway network consists of the following functional classifications:

- Freeways;
- Principal arterials; and,
- Minor arterials.

The adopted Comprehensive Plans for the five impacted communities in the study area were referenced and the study area roadway network was proposed. This network was also previously shown on Figure 8.01. Table 8.01 describes this network by City and jurisdiction.

Table 8.01
Study Area Thoroughfare Network

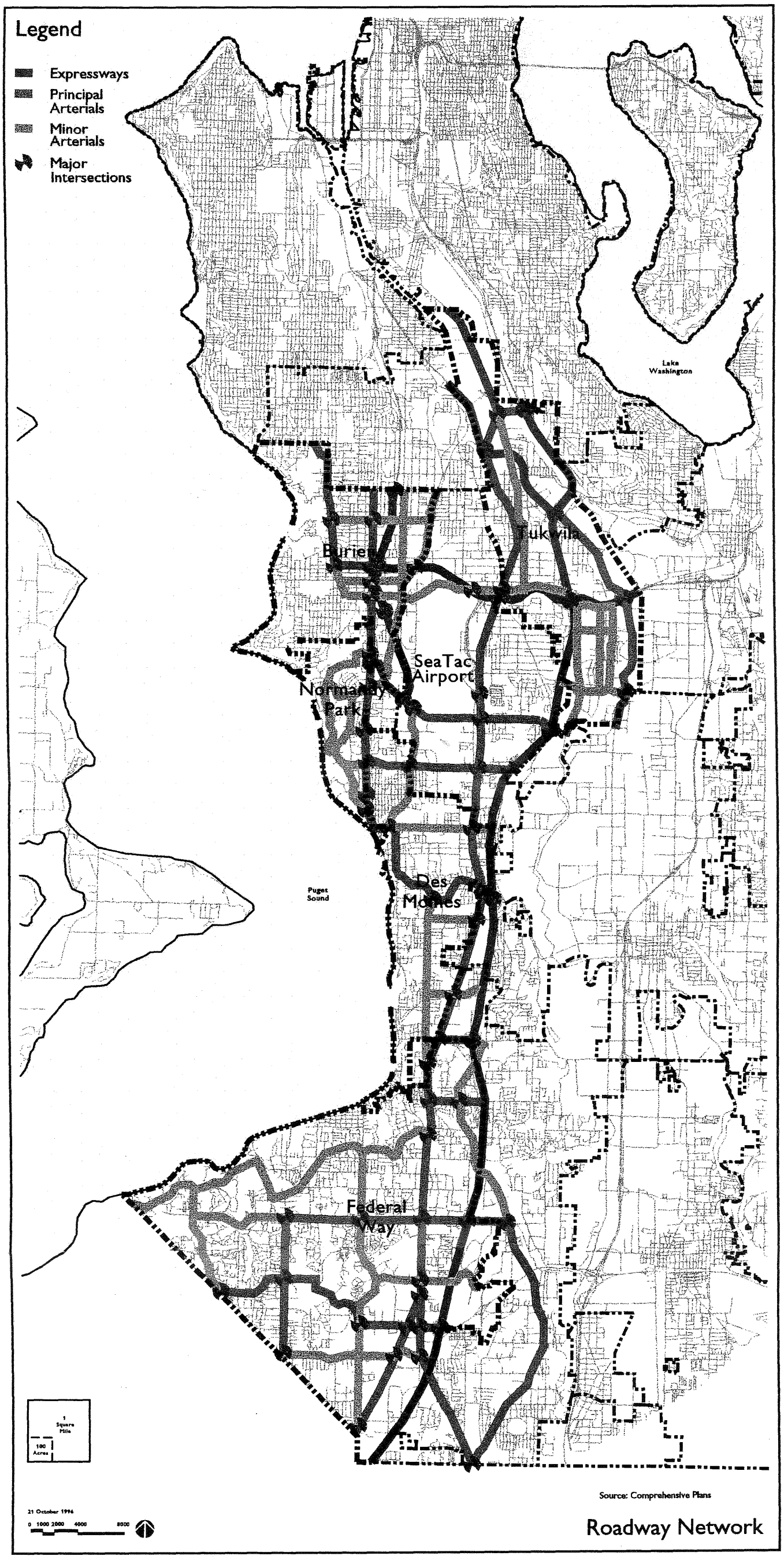
Functional Classification	Local					State
	Burien	Des Moines	Federal Way	Normandy Park	Tukwila	
State						
Freeways	- - -	- - -	- - -	- - -	- - -	31 miles
Principal arterials	- - -	- - -	- - -	- - -	- - -	6 miles
Local						
Principal arterials	5 miles	7 miles	19 miles	0 miles	9 miles	- - -
Minor arterials	9 miles	7 miles	21 miles	7 miles	11 miles	- - -
Number of major intersections	10	9	20	5	10	- - -

(Source: Draft and Adopted Comprehensive Plans for the Cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila)

The measurable factors (measures) for the following four areas of analysis used were:

- **Congestion**
  - Level of service
  - Accidents
  - School bus operations
  - Transit operations
  - Police and emergency operations
  - Parking and pedestrian circulation
  - Traffic noise (LEQ)

Figure 8.01
Thoroughfare Network



- **Physical Damage**
  - Local street system
  - State street system
  - Bridge ratings and pavement condition
  - Increased maintenance and reconstruction

- **Construction Impacts**
  - Truck haul routes
  - Barge/rail/conveyor systems
  - Traffic diversion
  - Traffic control
  - Construction staging and phasing
  - Work-force traffic
  - Concurrent construction projects

- **Post-Construction Impacts**
  - Additional traffic
  - Increased operation and maintenance costs
  - Master plan implementation

8.02 - TYPES OF IMPROVEMENTS

Reliable and current traffic data and a uniform set of forecasts for the Years 2000 and 2020 for the network of freeways, principal arterials and minor arterials surrounding the Airport was not available. Thus, an approach was taken in an attempt to quantify a level of mitigation for traffic and transportation impacts that would have the following attributes:

- Clear, reasonable and not overstated.

- Cost-effective in that a single mitigation item would address multiple impacts.

- Corridor-based and not spot-based improvements to enable an economy of scale and a comprehensive approach.

- Average unit-cost approach based upon actual program costs within the impacted communities.

- Program-based versus-project-based to enable the development of the project list when the detailed traffic study becomes available.

Two general types of improvements were developed into a mitigation program to address the issues of increased congestion and physical damage to the infrastructure - Increased Efficiency and Damage Reconstruction. These improvements are discussed below.

Increased Efficiency

The program of improvements developed to address congestion impacts are intended to be the minor Transportation System Management (TSM), or Congestion Management System (CMS), types of improvements applied on a corridor basis. They are not intended to be the heavy capital investment types of improvements. This approach was taken because it is recognized that not every roadway on the entire network is, or will be, in need of TSM/CMS type improvements as a result of the implementation of the Airport Master Plan. However, it is also recognized that there will be one major capital intensive project that will be identified as needed for mitigation. The objection is that the program "budget" for mitigation established on a TSM/CMS basis for the entire network will cover the actual expenditures when one route is not improved at all and another route needs a much greater investment than estimated using the unit cost approach. While the actual mitigation costs will not be fully known until contractor bids are opened, this approach appears to be the best basis of accuracy and reasonableness with the data available.

The type of TSM/CMS improvements considered include:

- Traffic signal interconnects.
- Re-timing of existing traffic signals.
- Upgrade signal controllers.
- New signal heads, masts, etc.
- New signalized intersections.
- Left/right turn lanes.
- Minor lane widening at intersections.
- Lane restriping
- Signage.
- Speed limitations
- Parking restrictions.
- Pedestrian signals and crosswalks.
- Sidewalks.
- Emergency vehicle signal pre-emption.

This program of TSM/CMS improvements does not provide any increases in the capacity of the existing network. It is intended to improve the flow of traffic with a minimum investment. If an increase in capacity of a particular route is identified as needed for mitigation, the TSM/CMS based program budgets should include the costs.

Damage Reconstruction

The second type of improvement investigated was directed at addressing the physical damage to the roadway network, primarily due to the "trucking-only" alternative for the haul of fill material during construction of the Third Runway, but also due to normal "wear and tear" on the system attributable to increased traffic. Normal deterioration is traditionally addressed by annualized resurfacing programs; however, a targeted mitigation program will be necessary to prevent excessive damage during the construction phase.

The primary focus during a truck-haul construction phases is damage to pavement and bridge decks caused by repeated heavy loads. This impact will be felt mostly on the State freeway network during the construction phase.

A major goal of this mitigation plan is to keep the haul trucks on the freeway network and construct a temporary connection from the freeway network directly into the Airport property and/or construction site without passing through the SR 509/SR 518 interchange which is reported to be the highest accident location in the region.

The first level of bridge repair is replacement of the deck, followed by rehabilitation of the bridge and in the most severe circumstance, replacement of the bridge at a very high cost. The mitigation program is based upon replacement of all the bridge decks within the study area, recognizing that not all decks will need to be replaced. The analysis further recognized that seismic retrofit of bridges in the study area may become a necessary element and added cost.

Aside from damage to the bridge decks, there is also the potential for damage to the pavement by the repeated heavy truck loads, particularly in areas where the pavement base may be weakened due to freeze-thaw activity or settlement around cross-pipes. The universally recognized pothole will become a constant maintenance issue during the haul activity.

The potential damage to the freeway pavement is focused on the heavy trucks during construction, while potential damage to the principal and minor arterials is primarily focused on increased general traffic loads which should be addressed by normal annualized resurfacing programs on the local streets. However, the frequency of scheduled repairs may increase due to increased traffic caused by the Airport Master Plan implementation.

The two types of improvements identified to mitigate physical damage impacts to the pavements on the State and local network is resurfacing, followed by the more expensive pavement reconstruction. Widening of roadways to increase capacity is not considered in the cost analysis.

The mitigation program for pavements is based upon a resurfacing (only) of the entire system every 5 years. This approach recognizes that not all routes need to be resurfaced every 5 years; however, some routes may need to be reconstructed once over the 25-year time-span of this analysis at three times the cost of a resurfacing.

Unit Costs

The unit costs developed for the mitigation of congestion and physical damage impacts were based upon the following sources:

- City of Burien Comprehensive Plan - GMA Transportation Element (The Transpo Group, Inc., 18 December 1995).

- City of Des Moines, Transportation Recommended Roadway Improvements (The Transpo Group, Inc., 18 October 1995).

- City of Federal Way Comprehensive Plan, Transportation Improvement Program (November 1995).

- City of SeaTac, 1997-2006 Transportation Improvement Program (7 June 1996).

- Puget Sound Regional Council, 1996-1998 Regional Transportation Improvement Program, King County Projects (28 September 1995).

- Washington State Department of Transportation, 1997-2016 State Highway System Plan, Northwest Region (March 1996).

The resultant average unit costs for the various types of mitigation obtained from the referenced transportation improvement programs were as follows:

• Signals and turn lanes	$500,000 per mile
• Corridor improvements	$1,400,000 per mile
• Bridge decks	$500,000 each
• Bridge rehabilitation	$600,000 each
• Bridge replacement	$1,800,000 each
• Bridge seismic retrofits	$1,000,000 each
• Roadway resurfacing	$400,000 per mile
• Roadway reconstruction	$1,300,000 per mile

These average unit costs were then applied to the roadway network as described previously for corridor-based congestion and physical damage impact mitigation program development. Within the study area the total network includes:

- 31 miles of freeways
- 36 miles of principal arterials
- 55 miles of minor arterials
- 54 major intersections

Bridges impacted were only on the State freeway system.

The resultant corridor-based, cost-effective program of TSM/CMS improvements, bridge repairs and resurfacing programs follows in Sections 8.03 through 8.25.

- City of Des Moines, Transportation Recommended Roadway Improvements (The Transpo Group, Inc., 18 October 1995).

- City of Federal Way Comprehensive Plan, Transportation Improvement Program (November 1995).

- City of SeaTac, 1997-2006 Transportation Improvement Program (7 June 1996).

- Puget Sound Regional Council, 1996-1998 Regional Transportation Improvement Program, King County Projects (28 September 1995).

- Washington State Department of Transportation, 1997-2016 State Highway System Plan, Northwest Region (March 1996).

The resultant average unit costs for the various types of mitigation obtained from the referenced transportation improvement programs were as follows:

• Signal interconnect	$200,000 per mile
• Signals and turn lanes	$500,000 per mile
• Corridor improvements	$1,400,000 per mile
• Bridge decks	$500,000 each
• Bridge rehabilitation	$600,000 each
• Bridge replacement	$1,800,000 each
• Bridge seismic retrofits	$1,000,000 each
• Roadway resurfacing	$400,000 per mile
• Roadway reconstruction	$1,300,000 per mile

These average unit costs were then applied to the roadway network as described previously for corridor-based congestion and physical damage impact mitigation program development. Within the study area the total network includes:

- 31 miles of freeways
- 36 miles of principal arterials
- 55 miles of minor arterials
- 54 major intersections

Bridges impacted were only on the State freeway system.

The resultant corridor-based, cost-effective program of TSM/CMS improvements, bridge repairs and resurfacing programs follows in Sections 8.03 through 8.25.

8.03 - CONGESTION - LEVEL OF SERVICE MITIGATION

Table 8.02 shows the acceptable Level of Service (LOS) established by each of the five impacted communities for its local streets. In most cases, the threshold is LOS "E". As traffic increases, local LOS may deteriorate, necessitating capital improvements to improve traffic flow. Further traffic studies will be necessary to determine where additional improvements are necessary to bring the LOS back up to "E".

Table 8.02
Acceptable LOS Levels in the Five Impacted Communities and King County

Area	LOS Criteria
Burien	Comprehensive Plan in development
Des Moines	D - residential E - commercial F - SR 99 corridor
Federal Way	E
Normandy Park	C
Tukwila	D - residential E - commercial
King County	E

An increase in traffic volumes will concurrently decrease the LOS of area thoroughfares. Each city has established acceptable performance levels - the average minimum LOS for each city is LOS "E". Table 8.03 projects study area neighborhoods in which the LOS deteriorates as a result of increased airport traffic. These LOS deteriorations may be addressed by the implementation of traffic system management projects which improve operations. An origin-destination survey, screen line analysis, or select-link analysis will be necessary to determine the amount of traffic impacts attributable to the proposed project.

It is recommended that the areas identified in Table 8.03 be mitigated prior to construction of the Third Runway. An origin-destination survey and a cost-allocation model should also be developed to determine the amount of impacts attributable to Airport traffic (see Section 8.24).

Table 8.03
Neighborhoods Identified for Level of Service Mitigation

City	Area	Amount
Burien	Shorewood neighborhood	$1.2 million
	North Central neighborhood	$1.6 million
	North East neighborhood	$9.8 million
	Central neighborhood	$1.3 million
	East Central neighborhood	$9.8 million
	Downtown neighborhood	$2.7 million
	Total - Burien	**$26.4 million**
Des Moines	North Hill neighborhood	$3.5 million
	West Central neighborhood	$1.6 million
	East Central neighborhood	$5.2 million
	Zenith neighborhood	$1.2 million
	South Des Moines neighborhood	$2.3 million
	East Woodmont neighborhood	$2.3 million
	West Woodmont neighborhood	$0.8 million
	Total - Des Moines	**$16.9 million**
Federal Way	Star Lake neighborhood	$4.0 million
	Wildwood neighborhood	$4.6 million
	Easter Lake neighborhood	$2.0 million
	Steel Lake neighborhood	$3.3 million
	First Avenue neighborhood	$1.7 million
	Kitts Corner North neighborhood	$2.1 million
	City Center neighborhood	$3.1 million
	Total - Federal Way	**$20.8 million**
Normandy Park	Bonniewood neighborhood	$0.2 million
	North neighborhood	$1.3 million
	Manhattan neighborhood	$1.0 million
	East Central neighborhood	$1.7 million
	Normandy Province neighborhood	$0.2 million
	Arrow Lake neighborhood	$0.6 million
	South neighborhood	$4.8 million
	Total - Normandy Park	**$9.8 million**
Tukwila	Ryan neighborhood	$0.8 million
	Allentown neighborhood	$4.0 million
	Cascade View neighborhood	$1.1 million
	Foster neighborhood	$1.5 million
	Thorndyke neighborhood	$4.3 million
	Tukwila Hill neighborhood	$4.9 million
	McMicken neighborhood	$1.0 million
	M.I.C. neighborhood	$8.6 million
	Riverton neighborhood	$3.8 million
	CBD neighborhood	$11.1 million
	Tukwila Valley South neighborhood	$2.6 million
	Total - Tukwila	**$43.7 million**
Total Study Area		**$117.6 million**

8.04 - CONGESTION - ACCIDENT MITIGATION

Neighborhoods with major intersections may experience an increase in accidents as traffic increases. Intersection improvements will be necessary to reduce this potential.

An increase in traffic volumes will concurrently increase the potential for accidents. However, the improvements made in association with TSM and CMS with concurrently reduce the potential for accidents on these same roadways. Therefore, neighborhoods that are projected to experience an increase in vehicular accidents associated with the proposed project will be concurrently mitigated by intersection improvements (see Table 8.03 above).

Preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of accident impacts are not shown at this time within the City of Federal Way.

8.05 - CONGESTION - SCHOOL BUS OPERATION MITIGATION

Neighborhoods with school bus routes may experience increases in delays and schedule adjustments due to increased local and diversion traffic during project construction and operation. The Highline School District may need to develop alternate routes to prevent lengthening of travel time and to minimize the impacts of traffic congestion. In the study area, only the cities of Burien, Des Moines, and Normandy Park are served by the Highline School District (Federal Way and Tukwila are served by other districts which were not part of this study.) The Highline School District also serves neighborhoods within the Cities of SeaTac and Seattle. In these instances, the school impacts were part of the study scope, but remaining other neighborhood impacts were not included.

An increase in traffic volumes will increase potential delays for school buses. Additional equipment, drivers, and alternate routes may be necessary to address these delays. An origin-destination survey, screen line analysis, or select-link analysis will be necessary to determine the number of bus routes affected by increased traffic associated with the proposed project. However, neighborhoods that are projected to experience an increase in school bus delays should be concurrently mitigated by intersection improvements (see Table 8.03 above). Additional equipment and alternative routes also may be necessary for these neighborhoods, plus additional neighborhoods in the Cities of SeaTac and Seattle which are served by the Highline School District. (As indicated above, preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of school bus impacts are not shown at this time within the City of Federal Way.)

It is recommended that any additional mitigation for Highline School District school bus impacts be assessed and completed prior to commencement of construction of the Third Runway. Highline School District school bus mitigation may include re-routing/rescheduling, relocation of bus-stops, and/or additional buses and drivers.

8.06 - CONGESTION - TRANSIT BUS OPERATION MITIGATION

Neighborhoods with regularly-scheduled public transit service may experience decreases in service due to increased local and diversion traffic during project construction and operation. The Regional Transit Authority (RTA) may need to develop alternate routes to prevent lengthening of travel time and to minimize the impacts of traffic congestion and cost of operations.

An increase in traffic volumes will increase potential delays for transit buses. Additional equipment, drivers, and alternate routes may be necessary to address these delays. An origin-destination survey, screen line analysis, or select-link analysis will be necessary to determine the number of bus routes affected by increased traffic associated with the proposed project. However, neighborhoods that are projected to experience an increase in transit bus delays should be concurrently mitigated by intersection improvements (see Table 8.03 above). Additional equipment and alternative routes may also be necessary for these neighborhoods. (Preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of transit bus impacts are not shown at this time within the City of Federal Way.)

It is recommended that any additional transit impact mitigation be assessed and completed prior to commencement of construction of the Third Runway. Transit mitigation may include re-routing/rescheduling, relocation of bus-stops, and/or additional buses and drivers.

8.07 - CONGESTION - POLICE AND EMERGENCY VEHICLE OPERATION MITIGATION

Increased local and diversion traffic during project construction and operation may hamper the ability of emergency vehicles to access all neighborhood areas. Additional equipment and personnel may be required to address the reduced response time. Additional public safety stations may be necessary to address response time problems.

An increase in traffic volumes will result in a decrease in the response time by emergency service personnel (police, fire, ambulance, etc.). Additional equipment, drivers, and new public safety sub-stations may be necessary to address these delays. An origin-destination survey, screen line analysis, or select-link analysis will be necessary to determine the number of emergency services affected by increased traffic associated with the proposed project. The neighborhoods that are projected to experience an decrease in response times should be concurrently mitigated by intersection improvements (see Table 8.03 above). Additional equipment, personnel, and station locations may eventually be necessary to address response time delays for these communities. (Preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of emergency vehicle access impacts are not shown at this time within the City of Federal Way.)

It is recommended that public safety response times in the five impacted communities be continually monitored during the construction phase of the Third Runway. Reductions in response times should be addressed by additional equipment, personnel, or new station locations. The origin-destination survey and cost-allocation model (Section 8.24) should be used to determine the amount of response time decrease attributable to Airport traffic.

8.08 - CONGESTION - PARKING AND PEDESTRIAN ACCESS MITIGATION

Increased local and diversion traffic during project construction and operation may negatively impact parking access to local businesses, schools, churches, and stores. Increased traffic may also conflict with pedestrian circulation. Additional parking, circulation, and pedestrian linkage studies are necessary to further determine these impacts.

An increase in traffic volumes will result in potential conflicts with pedestrian and parking circulation patterns. Intersection improvements associated with level of service improvements will simultaneously address these impacts (see Table 8.03). Preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of parking and pedestrian access impacts are not shown at this time within the City of Federal Way.

8.09 - CONGESTION - TRAFFIC NOISE MITIGATION

Neighborhoods adjacent to high-volume roadways (including freeways and principal and minor arterials) will experience an accompanying increase in traffic noise as traffic increases. Improvements to the traffic management system will address both traffic flow and noise.

An increase in traffic volumes will concurrently increase associated traffic noise. Traffic noise may be addressed by the installation of sound abatement wall systems along grade-separated highways and by constructing intersection improvements to smooth out traffic flow. An origin-destination survey, screen line analysis, or select-link analysis will be necessary to determine the amount of traffic impacts attributable to the proposed project. Intersection improvements associated with level of service improvements will simultaneously address traffic noise impacts (see Table 8.03). Preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of traffic noise impacts are not shown at this time within the City of Federal Way.

8.10 - PHYSICAL DAMAGE - LOCAL STREET SYSTEM MITIGATION

Neighborhoods that are subjected to increased traffic may experience decreases in the serviceability index (SI) of the roadways. Reconstruction of the local arterials will be necessary to improve the thoroughfares as the SI decreases. An origin-destination survey will be necessary to determine the extent to which this increase in traffic is attributable to the Airport. Table 8.04 delineates the neighborhoods projected to require mitigation for physical damage to the local street system.

It is recommended that the areas identified in Table 8.04 for local street mitigation be continually monitored for serviceability index decreases. Roadways where the SI decrease should be reconstructed as soon as possible. The cost-allocation model (Section 8.24) should determine the amount of damage attributable to Airport traffic.

Table 8.04
Neighborhoods Identified for Physical Damage Mitigation (Local System)

City	Area	Amount
Burien	Shorewood neighborhood	$1.2 million
	North Central neighborhood	$1.6 million
	North East neighborhood	$4.6 million
	Seahurst neighborhood	$0.7 million
	Central neighborhood	$1.3 million
	East Central neighborhood	$3.5 million
	Gregory Heights neighborhood	$0.6 million
	South East neighborhood	$2.0 million
	Downtown neighborhood	$1.4 million
	Total - Burien	**$16.9 million**
Des Moines	North Hill neighborhood	$1.4 million
	West Central neighborhood	$2.1 million
	North Central neighborhood	$2.1 million
	East Central neighborhood	$2.1 million
	Zenith neighborhood	$2.1 million
	South Des Moines neighborhood	$2.1 million
	West Woodmont neighborhood	$0.8 million
	East Woodmont neighborhood	$0.5 million
	Downtown neighborhood	$0.6 million
	Total - Des Moines	**$13.8 million**
Federal Way	Star Lake neighborhood	$1.4 million
	Wildwood neighborhood	$2.1 million
	Mirror Lake neighborhood	$0.8 million
	Easter Lake neighborhood	$0.5 million
	First Avenue neighborhood	$0.5 million
	City Center neighborhood	$1.1 million
	Total - Federal Way	**$6.4 million**
Normandy Park	Bonniewood neighborhood	$0.2 million
	North neighborhood	$1.3 million
	Riviera neighborhood	$1.9 million
	Manhattan neighborhood	$1.0 million
	East Central neighborhood	$1.7 million
	Normandy Province neighborhood	$0.2 million
	Arrow Lake neighborhood	$0.6 million
	South neighborhood	$4.8 million
	Total - Normandy Park	**$11.7 million**
Tukwila	Cascade View neighborhood	$1.1 million
	Foster neighborhood	$1.7 million
	Thorndyke neighborhood	$3.0 million
	Tukwila Hill neighborhood	$2.1 million
	McMicken neighborhood	$0.3 million
	M.I.C. neighborhood	$5.1 million
	Riverton neighborhood	$1.9 million
	CBD neighborhood	$10.0 million
	Tukwila Valley South neighborhood	$2.0 million
	Total - Tukwila	**$27.2 million**
Total Study Area		**$103.2 million**

8.11 - PHYSICAL DAMAGE - STATE STREET SYSTEM MITIGATION

Neighborhoods that are subjected to increased traffic may experience decreases in the SI of the State-jurisdiction roadways. Resurfacing and reconstruction of the State roads will be necessary to improve the highways as the SI decreases. An origin-destination survey will be necessary to determine the extent to which this increase in traffic is attributable to the Airport. Table 8.05 delineates the neighborhoods projected to require mitigation for physical damage to the State street system.

It is recommended that the areas identified in Table 8.05 for State street mitigation be continually monitored for serviceability index decreases. Roadways where the SI decrease should be reconstructed as soon as possible. The cost-allocation model (Section 8.24) should determine the amount of damage attributable to Airport traffic.

8.12 - PHYSICAL DAMAGE - BRIDGE RATINGS AND PAVEMENT CONDITION MITIGATION

Neighborhoods with bridges may experience a decrease in the load rating of the State-maintained bridge due to heavy truck loadings. Eventually, the bridge rating will decrease to the point that trucks may be diverted and reconstruction of the bridge will be required. An origin-destination survey will be necessary to determine the extent to which this loss in rating is attributable to the Airport. Table 8.06 indicates the neighborhoods which may become eligible for bridge deck replacement and mitigation.

Due to the high potential for damage to the State freeway system due to repeated heavy loads of maximum weight limit vehicles over an extended three-year period, an immediate survey of the conditions of the bridge decks and pavement condition is necessary to establish the baseline against which any damage claims can be assessed. Existing bridge ratings and pavement condition indices should be reviewed and updated and a continuous monitoring system established.

It is recommended that the Washington State Department of Transportation should establish the baseline conditions of the bridges and pavement on the freeway routes most likely to be used from the borrow pit locations to the construction site and establish a system of monitoring prior to any truck movements. The monitoring system should include weigh-in-motion, bridge deck instrumentation, mobile pavement condition survey vehicle(s), and selected closed-circuit television/video monitoring.

Table 8.05
Neighborhoods Identified for Physical Damage Mitigation (State System)

City	Area	Amount
Burien	North East neighborhood	$1.9 million
	East Central neighborhood	$1.2 million
	South East neighborhood	$0.9 million
	Total - Burien	**$4.0 million**
Des Moines	East Central neighborhood	$2.3 million
	South Des Moines neighborhood	$0.5 million
	East Woodmont neighborhood	$0.8 million
	Total - Des Moines	**$3.6 million**
Federal Way	Star Lake neighborhood	$2.0 million
	Wildwood neighborhood	$1.3 million
	Marine Hills neighborhood	$0.5 million
	Easter Lake neighborhood	$0.6 million
	Steel Lake neighborhood	$1.5 million
	First Avenue neighborhood	$0.5 million
	Kitts Corner North neighborhood	$1.1 million
	City Center neighborhood	$1.3 million
	Total - Federal Way	**$8.8 million**
Normandy Park	No neighborhoods in Normandy Park have been identified for physical damage mitigation (State system).	**$0.0 million**
Tukwila	Ryan neighborhood	$0.3 million
	Allentown neighborhood	$1.2 million
	Foster neighborhood	$1.3 million
	Thorndyke neighborhood	$1.5 million
	Tukwila Hill neighborhood	$2.0 million
	McMicken neighborhood	$1.5 million
	M.I.C. neighborhood	$1.5 million
	Riverton neighborhood	$0.7 million
	CBD neighborhood	$1.3 million
	Tukwila Valley South neighborhood	$0.3 million
	Total - Tukwila	**$11.6 million**
Total Study Area		**$28.0 million**

Table 8.06
Neighborhoods Identified for Bridge Mitigation

City	Area	Amount
Burien	North East neighborhood	$8.5 million
	East Central neighborhood	$10.2 million
	South East neighborhood	$5.1 million
	Total - Burien	**$23.8 million**
Des Moines	East Central neighborhood	$1.7 million
	Total - Des Moines	**$1.7 million**
Federal Way	Star Lake neighborhood	$1.7 million
	Wildwood neighborhood	$1.7 million
	Steel Lake neighborhood	$1.7 million
	Kitts Corner North neighborhood	$1.7 million
	Total - Federal Way	**$6.8 million**
Normandy Park	North neighborhood	$1.7 million
	Total - Normandy Park	**$1.7 million**
Tukwila	Foster neighborhood	$6.8 million
	Thorndyke neighborhood	$3.4 million
	Tukwila Hill neighborhood	$3.4 million
	M.I.C. neighborhood	$1.7 million
	CBD neighborhood	$3.4 million
	Tukwila Valley South neighborhood	$1.7 million
	Total - Tukwila	**$20.4 million**
Total Study Area		**$54.4 million**

8.13 - PHYSICAL DAMAGE - INCREASED MAINTENANCE AND RECONSTRUCTION MITIGATION

Neighborhoods in which the SI and maintenance cycle decreases due to increased traffic may experience increased frequency of resurfacing and maintenance due to the increased traffic volume. An origin-destination survey will be necessary to determine the extent to which this increase in traffic is attributable to the Airport. Table 8.07 indicates the neighborhoods which may be eligible for increased maintenance and reconstruction mitigation.

It is recommended that the areas identified in Table 8.07 for increased maintenance and reconstruction mitigation be continually monitored for serviceability index decreases. Roadways where the SI decrease should be reconstructed as soon as possible. The cost-allocation model (Section 8.24) should determine the amount of damage attributable to Airport traffic.

Table 8.07
Neighborhoods Identified for Maintenance/Reconstruction Mitigation

City	Area	Amount
Burien	Shorewood neighborhood	$0.5 million
	North Central neighborhood	$0.5 million
	North East neighborhood	$1.3 million
	Seahurst neighborhood	$0.2 million
	Central neighborhood	$0.4 million
	East Central neighborhood	$1.0 million
	Gregory Heights neighborhood	$0.2 million
	South East neighborhood	$0.6 million
	Downtown neighborhood	$0.4 million
	Total - Burien	**$5.1 million**
Des Moines	North Hill neighborhood	$1.0 million
	West Central neighborhood	$0.5 million
	East Central neighborhood	$0.5 million
	Zenith neighborhood	$0.3 million
	South Des Moines neighborhood	$0.8 million
	East Woodmont neighborhood	$0.4 million
	Downtown neighborhood	$0.1 million
	Total - Des Moines	**$3.6 million**
Federal Way	Star Lake neighborhood	$0.5 million
	Wildwood neighborhood	$0.5 million
	Marine Hills neighborhood	$0.3 million
	Mirror Lake neighborhood	$0.8 million
	Easter Lake neighborhood	$0.6 million
	Steel Lake neighborhood	$0.1 million
	First Avenue neighborhood	$0.6 million
	Kitts Corner North neighborhood	$0.1 million
	City Center neighborhood	$0.4 million
	Total - Federal Way	**$3.9 million**

Table 8.07 (continued)

City	Area	Amount
Normandy Park	Bonniewood neighborhood	$0.1 million
	North neighborhood	$0.5 million
	Riviera neighborhood	$0.7 million
	Manhattan neighborhood	$0.4 million
	East Central neighborhood	$0.6 million
	Normandy Province neighborhood	$0.1 million
	Arrow Lake neighborhood	$0.2 million
	South neighborhood	$1.7 million
	Total - Normandy Park	**$4.3 million**
Tukwila	Ryan neighborhood	$0.1 million
	Allentown neighborhood	$0.3 million
	Cascade View neighborhood	$0.3 million
	Foster neighborhood	$0.9 million
	Thorndyke neighborhood	$1.3 million
	Tukwila Hill neighborhood	$1.2 million
	McMicken neighborhood	$0.5 million
	M.I.C. neighborhood	$1.9 million
	Riverton neighborhood	$0.8 million
	CBD neighborhood	$3.2 million
	Tukwila Valley South neighborhood	$0.7 million
	Total - Tukwila	**$11.2 million**
Total Study Area		**$28.1 million**

8.14 - CONSTRUCTION IMPACTS - TRUCK HAUL ROUTES MITIGATION

Neighborhoods with principal and minor arterials may experience increased construction truck traffic. The EIS identifies 20 MCY of fill material that will be necessary for construction of the Third Runway. If this fill material is hauled by truck, it should be confined to State freeways. Traffic that would normally use these highways may divert to local roads to avoid the trucks. Individual cities may need to implement truck traffic controls and assign a traffic officer to control traffic and enforce truck haul routes. Table 8.08 indicates neighborhoods where traffic control officers may be necessary to address truck traffic associated with construction of the Third Runway.

Table 8.08
Neighborhoods Identified for Truck Haul Mitigation

City	Area	Amount
Burien	Shorewood neighborhood	$50,000/year/location
	North Central neighborhood	$50,000/year/location
	North East neighborhood	$50,000/year/location
	Seahurst neighborhood	$50,000/year/location
	Central neighborhood	$50,000/year/location
	East Central neighborhood	$50,000/year/location
	Gregory Heights neighborhood	$50,000/year/location
	South East neighborhood	$50,000/year/location
	Downtown neighborhood	$50,000/year/location
Des Moines	East Central neighborhood	$50,000/year/location
	South Des Moines neighborhood	$50,000/year/location
	East Woodmont neighborhood	$50,000/year/location
Federal Way	Star Lake neighborhood	$50,000/year/location
	Wildwood neighborhood	$50,000/year/location
	Easter Lake neighborhood	$50,000/year/location
	Kitts Corner North neighborhood	$50,000/year/location
	City Center neighborhood	$50,000/year/location
Normandy Park	No neighborhoods in Normandy Park have been identified for truck haul mitigation.	
Tukwila	Allentown neighborhood	$50,000/year/location
	Foster neighborhood	$50,000/year/location
	Thorndyke neighborhood	$50,000/year/location
	Tukwila Hill neighborhood	$50,000/year/location
	McMicken neighborhood	$50,000/year/location
	M.I.C. neighborhood	$50,000/year/location
	Riverton neighborhood	$50,000/year/location
	CBD neighborhood	$50,000/year/location
	Tukwila Valley South neighborhood	$50,000/year/location

Two general methods have been proposed to bring in the fill material - either by conventional truck or by barge on Puget Sound to a conveyor system. Each alternative has its "pros" and "cons". A separate study by HNTB, Inc., evaluated several alternatives and gave the barge/conveyor system a high rank. As of this study, it has not yet been determined which alternative will be selected.

The truck haul alternative requires more time to bring in the fill material and would impact area freeways with additional truck traffic, mostly dual-trailer dump trucks ("doubles") which will impact other vehicular traffic.

The barge/conveyor system will bring in the same amount of fill in approximately half the time, but has the potential to significantly impact the creek corridor and the barge/conveyor transfer point along the Puget Sound coast.

It is recommended that the Port of Seattle establish contingency plans for the various alternatives for bringing in the fill material. If the truck haul alternative is selected, the Port of Seattle should require the contractor to establish a truck haul route system that keeps haul traffic on State highways or intestates only. Haul traffic should not be allowed on local streets. Haul traffic should also have restricted hours of operation. The Port or its contractor should be financially responsible or provide traffic control officers at needed locations. The haul traffic should also have its own dedicated construction exit/entrance on the appropriate State or interstate highways.

It is further recommended that prior to the start of construction of any work associated with Master Plan Update implementation, the Port of Seattle should identify all borrow source areas and haul routes. Then, the Port of Seattle should re-evaluate the roadway noise analysis to reflect the actual haul routes.

8.15 - CONSTRUCTION IMPACTS - BARGE/RAIL/CONVEYOR SYSTEMS MITIGATION

An alternate to trucking is the use of a series of barges to bring the fill material in to a delivery point where it can be off-loaded onto a conveyor system. While physically twice as fast as the truck haul alternative, it may result in significant environmental damage to the chosen corridor and the nearby coastal areas. An environmental impact study of the barge/conveyor system seems warranted to assure the integrity of the chosen corridor. The plan should also include operational mitigation and corridor restoration upon completion. Table 8.09 indicates neighborhoods where mitigation of the barge/conveyor alternative may be required, if it is assumed that the conveyor is installed along Des Moines Creek.

It is recommended that the Port of Seattle establish contingency plans for the various alternatives for bringing in the fill material. If the barge/conveyor alternative is selected, an environmental assessment should be conducted of the delivery/transfer point, the selected creek corridor, and the coastal zone north and south of the delivery/transfer point to establish its baseline condition. After the material is delivered, these areas will then be restored to their baseline condition or better. The Port or its contractor should also prepare a plan that keeps non-authorized personnel out of the conveyor system, that minimizes noise impacts on adjacent residents, and that contains an emergency contingency plan that addresses pollution, spills, sedimentation, erosion, and other system failures.

Table 8.09
Neighborhoods Identified for Barge/Conveyor Mitigation

City	Area	Amount
Burien	South East neighborhood	$ to be determined
	Total - Burien	**$ to be determined**
Des Moines	West Central neighborhood	$ to be determined
	North Central neighborhood	$ to be determined
	Downtown neighborhood	$ to be determined
	Total - Des Moines	**$ to be determined**
Federal Way	No neighborhoods in Federal Way have been identified for barge/conveyor mitigation.	
Normandy Park	South neighborhood	$ to be determined
	Total - Normandy Park	**$ to be determined**
Tukwila	No neighborhoods in Tukwila have been identified for barge/conveyor mitigation.	
Total Study Area		**$ to be determined**

8.16 - CONSTRUCTION IMPACTS - TRAFFIC DIVERSION MITIGATION

An increase in traffic volumes on the freeways will divert a portion of the traffic onto local streets which are not designed for such volumes. This has a ripple effect where the traffic on the freeways divert to the principal arterials which divert to the minor arterials. Improvement to minor arterials may be necessary to accommodate this increase in traffic. An origin-destination survey will be necessary to determine the extent to which this increase in traffic is attributable to the Airport. However, neighborhoods that are projected to experience an increase in diverted traffic will be simultaneously mitigated by level of service improvements (see Table 8.03).

A computer model should be developed to project the amount of traffic diversion for various operations of heavy trucks on the freeways as well as congestion diversions due to the full Airport Master Plan implementation.

It is recommended that a diversion model be prepared for the project which includes the network as shown in Figure 8.01. Improvements to the arterial system as a result of diversion should be implemented prior to the start of the hauling activity on the freeways. An arterial improvement program should be implemented prior to the construction of the Third Runway.

8.17 - CONSTRUCTION IMPACTS - TRAFFIC CONTROL MITIGATION

Neighborhoods adjacent to the Airport that also have major intersections may experience increases in traffic congestion. Existing traffic signals should be modified or modernized as necessary. In some cases, uncontrolled intersections may require signalization. However, neighborhoods that are projected to experience an increase need for traffic control will be simultaneously mitigated by level of service improvements (see Table 8.03).

8.18 - CONSTRUCTION IMPACTS - CONSTRUCTION STAGING AND PHASING MITIGATION

Neighborhoods adjacent to the construction site may experience impacts as result of construction operations and traffic. Traffic management improvement implemented in the congestion measures should automatically address these concerns. All other staging and phasing issues should be limited to on-Airport locations. However, neighborhoods that are projected to experience an increase need for traffic control will be simultaneously mitigated by level of service improvements (see Table 8.03).

8.19 - CONSTRUCTION IMPACTS - WORK-FORCE TRAFFIC MITIGATION

The Port of Seattle estimates approximately 2,000 construction workers will be employed during construction of the proposed project. There may be some localized traffic congestion at staging and other areas. In these cases, it is projected that this traffic will be mitigated by improvements made to address level of service problems (see Table 8.03).

8.20 - CONSTRUCTION IMPACTS - CONCURRENT CONSTRUCTION PROJECTS MITIGATION

There is the potential for other major projects to be simultaneously under construction in southern and central King County at the same time the Third Runway is being built, including:

- Regional Transit Authority (RTA) improvements for light-rail and bus-lanes.
- Construction of the new Mariners Ballpark stadium.
- Relocation or reconstruction of the Kingdome.
- Improvements to IH-5.
- Construction of the SR 509 extension.
- Improvements to SR 518.
- Improvements to SH 99/International Boulevard.

Overlapping construction phases of these projects (and others) combined with construction of the Third Runway could have significant impacts on the region's ability to meet traffic demand.

If these projects are not managed concurrently, there is the potential to impact **every neighborhood in every city in the study area**. Therefore, it is urged that the various implementing agencies establish a dialogue as soon as possible to prevent this overlapping from occurring, or at least to minimize impacts associated with phases that must overlap.

All neighborhoods in all impacted communities are projected to be impacted by overlapping concurrent projects. Each City should estimate the need for another 25% to its average annual transportation budget to address the need for short-term projects and studies.

8.21 - POST-CONSTRUCTION IMPACTS - ADDITIONAL TRAFFIC MITIGATION

An increase in traffic is expected to occur after construction is completed and the Third Runway is operational, requiring additional improvements to intersections, signalization, and roadway capacity. Neighborhoods with principal arterials that are adjacent to the Airport may experience increased traffic as a result of increased Airport demand. Additional transportation improvement projects may be necessary to address this increase in traffic. As stated above, an origin-destination survey will be necessary to determine the extent to which traffic is attributable to the Airport. Table 8.10 lists those neighborhoods that may require additional traffic mitigation.

It is recommended that the areas identified in Table 8.10 be monitored for additional traffic impacts after the Third Runway is operational. If traffic impacts exceed EIS projections, the cost-allocation model (Section 8.24) should be used to determine the amount of mitigation required due to Airport-related traffic impacts.

Preliminary estimation of mitigation costs for transportation impacts within the City of Federal Way will be deferred until the Areawide Traffic Study has been completed. Therefore, cost estimates for mitigation of additional traffic impacts are not shown at this time within the City of Federal Way.

Table 8.10
Neighborhoods Identified for Additional Traffic Mitigation

City	Area	Amount
Burien	Shorewood neighborhood	$2.4 million
	North Central neighborhood	$3.2 million
	North East neighborhood	$12.0 million
	Seahurst neighborhood	$2.6 million
	Central neighborhood	$2.6 million
	East Central neighborhood	$9.2 million
	South East neighborhood	$3.2 million
	Downtown neighborhood	$5.4 million
	Total - Burien	**$40.6 million**
Des Moines	North Hill neighborhood	$7.0 million
	West Central neighborhood	$3.2 million
	East Central neighborhood	$10.4 million
	Zenith neighborhood	$2.4 million
	South Des Moines neighborhood	$4.6 million
	East Woodmont neighborhood	$4.6 million
	Downtown neighborhood	$1.0 million
	Total - Des Moines	**$33.2 million**
Federal Way	No neighborhoods in Federal Way have been identified for mitigation of additional traffic.	**$0.0 million**
Normandy Park	Bonniewood neighborhood	$0.4 million
	North neighborhood	$2.6 million
	Riviera neighborhood	$3.8 million
	Manhattan neighborhood	$2.0 million
	East Central neighborhood	$3.4 million
	Normandy Province neighborhood	$0.4 million
	Arrow Lake neighborhood	$1.2 million
	South neighborhood	$9.6 million
	Total - Normandy Park	**$23.4 million**
Tukwila	Ryan neighborhood	$0.6 million
	Allentown neighborhood	$2.4 million
	Cascade View neighborhood	$2.2 million
	Foster neighborhood	$6.0 million
	Thorndyke neighborhood	$9.0 million
	Tukwila Hill neighborhood	$8.2 million
	McMicken neighborhood	$3.6 million
	M.I.C. neighborhood	$13.2 million
	Riverton neighborhood	$5.2 million
	CBD neighborhood	$22.6 million
	Tukwila Valley South neighborhood	$4.6 million
	Total - Tukwila	**$90.8 million**
Total Study Area		**$188.0 million**

8.22 - POST-CONSTRUCTION IMPACTS - INCREASED OPERATION AND MAINTENANCE COSTS MITIGATION

Neighborhoods with principal arterials that are adjacent to the Airport may experience increased maintenance costs as a result of increased Airport demand. Additional maintenance improvement projects may be necessary to address this increase in maintenance frequency. As stated above, an origin-destination survey will be necessary to determine the extent to which traffic is attributable to the Airport. However, improvements made to address level of service improvements (see Table 8.03) should also simultaneously address the needs for increased operation and maintenance costs.

8.23 - POST-CONSTRUCTION IMPACTS - MASTER PLAN IMPLEMENTATION MITIGATION

As the Airport's Master Plan is implemented, additional traffic may be experienced as a result of more employees, more airline personnel, more travelers, and more support services. Additional transportation improvement projects may be necessary to address this increase in traffic. As stated above, an origin-destination survey will be necessary to determine the extent to which traffic is attributable to the Airport. However, improvements made to address level of service improvements (see Table 8.03) should also simultaneously address the additional demands as a result of the full Master Plan Update implementation.

Like the existing conditions analysis, the future analysis should be evaluated again by the Port of Seattle in order to reflect more accurately the information available prior to the start of construction for Master Plan Update implementation. This, is in part, to reflect actual Airport area traffic information due to growth, changes in any traffic patterns, etc. The re-evaluation would benefit from the following:

- More accurate information on construction activities, in particular haul routes, so that construction traffic can be included in the roadway noise re-evaluation.
- More accurate information on vehicle classification and their use of the various roadways.
- The additional monitoring data obtained from the roadway noise monitoring sites.

8.24 - OTHER TRANSPORTATION MITIGATION MEASURES

Section 3 of this report analyzed the Airport's EIS and raised several concerns regarding the information presented on transportation issues. As a result, many of the projected transportation impacts and mitigation costs presented in this Section must be considered preliminary, at best, until the necessary studies are completed.

This study recommends that supplemental transportation studies be conducted **prior to Federal and State approval to proceed with the project.** While the Port of Seattle is the project sponsor, responsibility for these studies is expected to be the responsibility of various agencies and may involve at least the PSRC, the State of Washington Department of Transportation, the City of Seattle, King County, and the Port of Seattle.

The following supplemental transportation studies are suggested to be conducted prior to project approval.

Areawide Traffic Study

While the EIS performed an acceptable analysis of traffic at the 12 major intersections surrounding the Airport property, many issues regarding increased congestion and damage to streets will continue to be raised until hard data is available within the entire study area.

An areawide traffic study should be undertaken for the South King County area, including the Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila, to establish existing baseline conditions and forecast levels of service on the roadway network as shown in Figure 8.01. This study should, as best possible, forecast traffic for the following time-frames:

- 1994 - EIS baseline.
- 1997 - Current.
- 2000 - EIS completion of Third Runway.
- 2020 - EIS full Airport Master Plan implementation.

This study should:

- Build upon the existing transportation plans of the above cities.
- Establish common level of service criteria for mitigation of Airport impacts.
- Address the issue of concurrent construction projects in the forecasts.
- Be conducted on a corridor-basis.
- Provide for monitoring and updating.
- Determine the current and projected levels of service on the network and major intersections.

It is recommended that as the project sponsor, the Port of Seattle should expand the EIS traffic analysis to the entire network as shown in Figure 8.01.

Origin-Destination (O-D) Survey

One of the key questions raised in Section 3 of this report was the affect of increased traffic on the local and State thoroughfare networks. According to Airport projections, future demand will roughly double whether or not the Airport expands its facilities. During this same time-frame, it is logical to project that there will be **some** increase in regional traffic unrelated to Sea-Tac International Airport. But it has not yet been determined what percentage of future traffic will be attributable to the Airport and what percentage is attributable to non-Airport regional growth.

Development of an origin-destination survey (or select link analysis or screen-line analysis) will project these percentages on major local and State roadways. The O-D survey should be the basis for assigning financial responsibility for transportation improvements which benefit various land uses, including the Airport.

It is recommended that in its capacity as the region's metropolitan transportation planning agency, the Puget Sound Regional Council should conduct an origin-destination (O-D) survey to determine the amount of regional traffic attributable to Sea-Tac International Airport. This survey should use the most recent data available and may necessitate extensive data collection and sampling of motorists. The percentage of traffic attributable to the Airport should be projected to the year 2020 in 5-year increments and be used for projecting cost-sharing of various transportation projects that serve and benefit Sea-Tac International Airport. These projects include, but are not limited to:

- **Thoroughfare projects to reduce traffic noise and accidents and to improve level of service.**
- **Thoroughfare projects to improve school bus, transit bus, and emergency service operations.**
- **Thoroughfare projects to improve parking and pedestrian circulation.**
- **Repair/reconstruction/replacement of local streets and State roads and bridges.**
- **Increased frequency of maintenance and reconstruction of local and State roadways.**
- **Traffic control measures to manage construction and diverted traffic.**
- **Traffic control measures to manage future traffic of the full Airport Master Plan build-out.**

Cost Allocation Model

After completion of an updated O-D study, the calculation of a *pro rata* share of transportation impact costs attributable to construction of the Third Runway and implementation of the full Airport Master Plan becomes possible. This allocation model should be based upon the O-D results, negotiated with the impacted communities and **be part of an interlocal agreement before construction of the Third Runway begins.**

It is recommended that the estimated mitigation costs calculated in Section 8 of this report should be recalculated taking into consideration the O-D information recommended above. Costs for mitigation projects should be assigned to the Port of Seattle only if those impacts are attributable to traffic as a result of the Third Runway. Other transportation projects would be implemented by the appropriate local, county, State, and/or Federal agencies. Costs to be recalculated include:

- **Traffic noise abatement projects.**
- **Local/State street reconstruction and bridge replacement projects.**
- **Increased maintenance and reconstruction projects.**
- **Construction traffic control projects.**
- **Additional traffic impacts (for full Airport Master Plan build-out).**

Projects that have not been estimated in this study but will eventually require calculation include:

- **Level of service improvements.**
- **School bus and transit bus routes, scheduling, equipment, and staffing improvements.**
- **Police and emergency service routes, equipment, staffing, and response time improvements.**
- **Parking access and pedestrian circulation improvements.**

Incident Management Plan

With the expected increase of heavy haul trucks on the freeways during the construction phase of the Third Runway, there is a high likelihood that the type, frequency and severity of accidents currently experienced will change; possibly dramatically. To prepare for this haul period, a Freeway Incident Management Plan should be prepared prior to any hauling permits being issued and should include:

- Detection systems.
- Emergency services protocols.
- Control of the accident scene.
- Fast transport of injured.
- Traffic diversion points.
- Diversion/detour routes.
- Roles and responsibilities identified.
- Accident investigation sites.

This system would also respond to spills and should be based upon state-of-the-art telecommunications techniques.

It is recommended that the Washington Department of Transportation develop a Freeway Incident Management Plan for the construction phase and also impose operational restrictions on the heavy trucks involved with the haul and consider:

- **Haul truck climbing lanes.**
- **Lane restrictions.**
- **Time-of-day restrictions.**
- **Weight/length restrictions.**
- **Permitting/fines system.**

Surface Transportation Noise Mitigation

- **Regulatory Compliance** - The Port of Seattle should comply with all appropriate Federal, State and local noise regulatory requirements for surface transportation of fill and other materials associated with Master Plan Update implementation.

- **Construction Time-Limits** - All construction operations, including heavy equipment and trucks hauling fill, should only operate between the hours of 7:00 AM and 9:00 PM Monday through Friday and 9:00 AM to 9:00 PM on Saturdays. No operations should be allowed on Sundays or holidays.

- **Noise Control Devices** - All construction equipment, including trucks hauling fill, should be equipped with noise control devices which should be at least as effective as those devices provided with the original equipment.

- **Complaint-Driven Requirements** - If noise complaints are received during construction, the Port of Seattle should at least implement one or more of the following:

  - Locate stationary construction equipment as far from nearby noise sensitive properties as possible.

  - Shut off idling equipment.

  - Re-schedule construction operations to avoid periods of noise annoyance.

  - Notify nearby residents whenever extremely noisy work will be occurring.

  - Install temporary or portable acoustic barriers around stationary construction noise sources.

  - Place material stockpiles between crushing or screening operations and the affected dwelling(s).

- **Remodeling** - Depending on when the Master Plan Update implementation is started, existing surface transportation noise should be remodeled by the Port of Seattle with the then-current version of STAMINA or the most accepted program. This will allow a comparison with the 1994 existing baseline conditions and the actual conditions at the start of construction. In order to plan for this re-evaluation, the following should be done:

  - Specific roadway noise monitoring sites should be established at key locations, possibly some of the sites identified as being noise impacted by the Federal Highway Administration noise sensitivity criterion; the locations of these sites should be coordinated with the establishment of additional aircraft noise monitoring sites; data collection from these noise monitoring sites should begin as soon as possible in order to provide up-to-date baseline information before Master Plan Update implementation construction starts.

  - More accurate traffic information should be obtained for the roads in the Airport area (e.g., vehicle categories and road use); the EIS indicates that relevant data was available only on I-5 and International Boulevard for surveys conducted on 3 August 1987; 8 July 1991; and 25 February 1992.

- **Clarify INM and Surface Traffic Noise** - The INM incorporated aircraft ground noise in its analysis. However, it was not clear if this included construction and other surface traffic, in particular traffic associated with hauling fill. This should be clarified by the Port of Seattle and if necessary the interaction between surface transportation and aircraft noise levels should be evaluated including the construction traffic.

8.25 - TRANSPORTATION IMPACT SUMMARIES

Plates 8.1 through 8.6 summarize the environmental impacts for each of the five impacted communities, plus the Highline School District and Highline Community Hospital. The impact, mitigation measure, and cost is identified for each neighborhood. The following conventions should be noted when reviewing these Plates:

- **"- - -"** - Indicates that there is no impact identified for this neighborhood.
- **"$ TBD"** - Indicates that the mitigation costs are yet to be determined. Not enough information was available during this study to determine these costs.
- **"$0.0 M"** - Indicates that there are no mitigation costs for this neighborhood.
- **"Mitigated by . . . measures"** - Indicates that other mitigation measures simultaneously mitigate this neighborhood for multiple impact types.
- **"See . . . matrix"** - (Appears only in the Public Facility matrix) Indicates that these impacts are addressed by measures delineated in another City/neighborhood matrix.
- **"Outside Study Area"** - (Appears only in the Public Facility matrix) Indicates that only impacts to the school/hospital building are delineated. Analysis of other impacts are outside the scope of the study.

TRANSPORTATION IMPACT MATRIX - CITY OF BURIEN

PLATE 8.1

Neighborhood		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle operations	Parking & Pedestrian Access	Traffic Noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construct. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
Shorewood	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(601 acres)	*Cost*	$1.2 M	measures	measures	measures	measures	measures	measures	$1.2 M	---	---	$0.5 M	$50,000 /year per location	---	measures	measures	measures	measures	$ TBD	$2.4 M	measures	measures
North Central	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(488 acres)	*Cost*	$1.6 M	measures	measures	measures	measures	measures	measures	$1.6 M	---	---	$0.5 M	$50,000 /year per location	---	measures	measures	measures	measures	$ TBD	$3.2 M	measures	measures
North East	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(707 acres)	*Cost*	$9.8 M	measures	measures	measures	measures	measures	measures	$4.6 M	$1.9 M	$8.5 M	$1.3 M	$50,000 /year per location	---	measures	measures	measures	measures	$ TBD	$12.0 M	measures	measures
Seahurst Park	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(166 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
Seahurst	*Impact*	---	---	---	---	---	---	---	Road damage	---	---	Pavement damage	Increased truck traffic	---	---	---	---	---	Regional traffic	Additional traffic	---	---
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	---	---	Increase maint.	Traffic control	---	---	---	---	---	Transp. manage. plan	Corridor improve's.	---	---
(393 acres)	*Cost*	---	---	---	---	---	---	---	$0.7 M	---	---	$0.2 M	$50,000 /year per location	---	---	---	---	---	$ TBD	$2.6 M	---	---
Central	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(156 acres)	*Cost*	$1.3 M	measures	measures	measures	measures	measures	measures	$1.3 M	---	---	$0.4 M	$50,000 /year per location	---	measures	measures	measures	measures	$ TBD	$2.6 M	measures	measures
Lake Burien	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(162 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
East Central	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(254 acres)	*Cost*	$9.8 M	measures	measures	measures	measures	measures	measures	$3.5 M	$1.2 M	$10.2 M	$1.0 M	$50,000 /year per location	---	measures	measures	measures	measures	$ TBD	$9.2 M	measures	measures
South West	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(365 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
Gregory Heights	*Impact*	---	---	---	---	---	---	---	Road damage	---	---	Pavement Damage	Increased truck traffic	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	---	---	Increase maint.	Traffic control	---	---	---	---	---	Transp. manage. plan	---	---	---
(574 acres)	*Cost*	---	---	---	---	---	---	---	$0.6 M	---	---	$0.2 M	$50,000 /year per location	---	---	---	---	---	$ TBD	---	---	---
South East	*Impact*	---	---	---	---	---	---	---	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	Corridor damage	---	---	---	---	Regional traffic	Additional traffic	---	---
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	Reconstruct corridor	---	---	---	---	Transp. manage. plan	Corridor improve's.	---	---
(268 acres)	*Cost*	---	---	---	---	---	---	---	$2.0 M	$0.9 M	$5.1	$0.6 M	$50,000 /year per location	$ TBD	---	---	---	---	$ TBD	$3.2 M	---	---
Downtown	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(308 acres)	*Cost*	$9.8 M	measures	measures	measures	measures	measures	measures	$1.4 M	---	---	$0.4 M	$50,000 /year per location	---	measures	measures	measures	measures	$ TBD	$5.4 M	measures	measures
Total (4,442 ac.)		$116.8 M plus TBD	$26.4 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$16.9 M	$4.0 M	$23.8 M	$5.1 M	$50,000 /year per location	$ TBD	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$40.6 M	$0.0 M	$0.0 M

TRANSPORTATION IMPACT MATRIX - CITY OF DES MOINES

PLATE 8.2

Neighborhood		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle access	Parking & pedestrian access	Traffic noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construc. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
North Hill	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(623 acres)	*Cost*	$3.5 M	measures	measures	measures	measures	measures	measures	$1.4 M	---	---	$1.0 M	---	---	measures	measures	measures	measures	$ TBD	$7.0 M	measures	measures
West Central	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	Corridor damage	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	Reconstruct corridor	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(479 acres)	*Cost*	$1.6 M	measures	measures	measures	measures	measures	measures	$2.1 M	---	---	$0.5 M	---	$ TBD	measures	measures	measures	measures	$ TBD	$3.2 M	measures	measures
North Central	*Impact*	---	---	---	---	---	---	---	Road damage	---	---	---	---	Corridor damage	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	---	---	---	---	Reconstruct corridor	---	---	---	---	Transp. manage. plan	---	---	---
(241 acres)	*Cost*	---	---	---	---	---	---	---	$2.1 M	---	---	---	---	$ TBD	---	---	---	---	$ TBD	---	---	---
East Central	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(626 acres)	*Cost*	$5.2 M	measures	measures	measures	measures	measures	measures	$2.1 M	$2.3 M	$1.7 M	$0.5 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$10.4 M	measures	measures
Zenith	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
($50 acres)	*Cost*	$1.2 M	measures	measures	measures	measures	measures	measures	$2.1 M	---	---	$0.3 M	---	---	measures	measures	measures	measures	$ TBD	$2.4 M	measures	measures
South Des Moines	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(492 acres)	*Cost*	$2.3 M	measures	measures	measures	measures	measures	measures	$2.1 M	$0.5 M	---	$0.8 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$4.6 M	measures	measures
West Woodmont	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	---	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Insulation/ easement	by LOS	by LDN	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	---	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(430 acres)	*Cost*	$2.3 M	measures	measures	measures	measures	measures	measures	$0.8 M	---	---	---	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	---	measures	measures
East Woodmont	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Insulation/ easement	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(306 acres)	*Cost*	$0.8 M	measures	measures	measures	measures	measures	measures	$0.5 M	$0.8 M	---	$0.4 M	---	---	measures	measures	measures	measures	$ TBD	$4.6 M	measures	measures
Redondo	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(212 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
Downtown	*Impact*	---	---	---	---	---	---	---	Road damage	---	---	Pavement damage	---	Corridor damage	---	---	---	---	Regional traffic	Additional traffic	---	---
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	---	---	Increase maint.	---	Reconstruct corridor	---	---	---	---	Transp. manage. plan	Corridor improve's.	---	---
(108 acres)	*Cost*	---	---	---	---	---	---	---	$0.6 M	---	---	$0.1 M	---	$ TBD	---	---	---	---	$ TBD	$1.0 M	---	---
Total (4,067 ac.)		$72.8 M plus TBD	$16.9 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$13.8 M	$3.6 M	$1.7 M	$3.6 M	$50,000/year per location	$ TBD	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$33.2 M	$0.0 M	$0.0 M

TRANSPORTATION IMPACT MATRIX - CITY OF FEDERAL WAY

PLATE 8.3

Neighborhood		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle access	Parking & pedestrian access	Traffic noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construc. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
Star Lake	*Impact*	Traffic congestion	---	---	---	---	---	---	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's.	---	---	---	---	---	---	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(531 acres)	*Cost*	$4.0 M	---	---	---	---	---	---	$1.4 M	$2.0 M	$1.7 M	$0.5 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	---	measures	measures
Wildwood	*Impact*	Traffic congestion	---	---	---	---	---	---	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's.	---	---	---	---	---	---	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(553 acres)	*Cost*	$4.6 M	---	---	---	---	---	---	$2.1 M	$1.3 M	$1.7 M	$0.5 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	---	measures	measures
Marine Hills	*Impact*	---	---	---	---	---	---	---	---	Road damage	---	Pavement damage	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	Reconstruct roads	---	Increase maint.	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(529 acres)	*Cost*	---	---	---	---	---	---	---	---	$0.5 M	---	$0.3 M	--	---	---	---	---	---	$ TBD	---	---	---
Mar-Cheri	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(311 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
Dash Point	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(826 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
Lakota	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(949 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
Mirror Lake	*Impact*	---	---	---	---	---	---	---	Road damage	---	---	Pavement damage	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	---	---	Increase maint.	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(713 acres)	*Cost*	---	---	---	---	---	---	---	$0.8 M	---	---	$0.8 M	---	---	---	---	---	---	$ TBD	---	---	---
Easter Lake	*Impact*	Traffic congestion	---	---	---	---	---	---	Road damage	Road damage	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's.	---	---	---	---	---	---	Reconstruct roads	Reconstruct roads	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(729 acres)	*Cost*	$2.0 M	---	---	---	---	---	---	$0.5 M	$0.6 M	---	$0.6 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	---	measures	measures
Steel Lake	*Impact*	Traffic congestion	---	---	---	---	---	---	---	Road damage	Bridge damage	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's.	---	---	---	---	---	---	---	Reconstruct roads	Replace bridges	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(347 acres)	*Cost*	$3.3 M	---	---	---	---	---	---	---	$1.5 M	$1.7 M	$0.1 M	---	---	measures	measures	measures	measures	$ TBD	---	measures	measures
Twin Lakes	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(1,118 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---

TRANSPORTATION IMPACT MATRIX - CITY OF FEDERAL WAY (continued)

PLATE 8.3 (continued)

NEIGHBORHOOD		CONGESTION							PHYSICAL DAMAGE				CONSTRUCTION IMPACTS							POST-CONSTRUCTION IMPACTS		
NAME	MEASURES	LEVEL OF SERVICE (LOS)	ACCIDENTS	SCHOOL BUS OPERATIONS	TRANSIT BUS OPERATIONS	POLICE & EMERGENCY VEHICLE ACCESS	PARKING & PEDESTRIAN ACCESS	TRAFFIC NOISE (LEQ)	LOCAL STREETS	STATE ROADS	STATE BRIDGES	INCREASED MAINTEN./ RECONSTRUC.	TRUCK HAUL ROUTES	BARGE/RAIL CONVEYOR SYSTEM	TRAFFIC DIVERSION	TRAFFIC CONTROL	CONSTRUCT. STAGING/ PHASING	WORK-FORCE TRAFFIC	CONCURRENT CONSTRUC. PROJECTS	ADDITIONAL TRAFFIC	INCREASED OPERATION/ MAINTENANCE COSTS	MASTER PLAN UPDATE
West Campus	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(848 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
First Avenue	*Impact*	Traffic congestion	---	---	---	---	---	---	Road damage	Road damage	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's	---	---	---	---	---	---	Reconstruct roads	Reconstruct roads	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(546 acres)	*Cost*	$1.7 M	---	---	---	---	---	---	$0.5 M	$0.5 M	---	$0.6 M	---	---	measures	measures	measures	measures	$ TBD	---	measures	measures
Kitts Corner North	*Impact*	Traffic congestion	---	---	---	---	---	---	---	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's	---	---	---	---	---	---	---	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(299 acres)	*Cost*	$2.1 M	---	---	---	---	---	---	---	$1.1 M	$1.7 M	$0.1 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	---	measures	measures
City Center	*Impact*	Traffic congestion	---	---	---	---	---	---	Road damage	Road damage	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	---	Mitigated	Mitigated
	Mitigation	Corridor improve's	---	---	---	---	---	---	Reconstruct roads	Reconstruct roads	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	---	by LOS	by LOS
(430 acres)	*Cost*	$3.1 M	---	---	---	---	---	---	$1.1 M	$1.3 M	---	$0.1 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	---	measures	measures
Total (8,719 ac.)	$46.7 M plus TBD	$20.8 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$6.4 M	$8.8 M	$6.8 M	$3.9 M	$50,000/year per location	$ 0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$0.0 M	$0.0 M	$0.0 M

TRANSPORTATION IMPACT MATRIX - CITY OF NORMANDY PARK

PLATE 8.4

Neighborhood		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle access	Parking & pedestrian access	Traffic noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construc. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
Bonniewood	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(41 acres)	*Cost*	$0.2 M	measures	measures	measures	measures	measures	measures	$0.2 M	---	---	$0.1 M	---	---	measures	measures	measures	measures	$ TBD	$0.4 M	measures	measures
Highlands	*Impact*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Regional traffic	---	---	---
	Mitigation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Transp. manage. plan	---	---	---
(81 acres)	*Cost*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	$ TBD	---	---	---
North	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	Bridge damage	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	Replace bridges	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(348 acres)	*Cost*	$1.2 M	measures	measures	measures	measures	measures	measures	$1.3 M	---	$1.7 M	$0.5 M	---	---	measures	measures	measures	measures	$ TBD	$2.6 M	measures	measures
Riviera	*Impact*	---	---	---	---	---	---	---	Road damage	---	---	Pavement damage	---	---	---	---	---	---	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	---	---	---	---	---	---	---	Reconstruct roads	---	---	Increase maint.	---	---	---	---	---	---	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(240 acres)	*Cost*	---	---	---	---	---	---	---	$1.9 M	---	---	$0.7 M	---	---	---	---	---	---	$ TBD	$3.8 M	measures	measures
Manhattan	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(90 acres)	*Cost*	$1.0 M	measures	measures	measures	measures	measures	measures	$1.0 M	---	---	$0.4 M	---	---	measures	measures	measures	measures	$ TBD	$2.0 M	measures	measures
East Central	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(248 acres)	*Cost*	$1.7 M	measures	measures	measures	measures	measures	measures	$1.7 M	---	---	$0.6 M	---	---	measures	measures	measures	measures	$ TBD	$3.4 M	measures	measures
Normandy Province	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(39 acres)	*Cost*	$0.2 M	measures	measures	measures	measures	measures	measures	$0.2 M	---	---	$0.1 M	---	---	measures	measures	measures	measures	$ TBD	$0.4 M	measures	measures
Arrow Lake	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(29 acres)	*Cost*	$0.6 M	measures	measures	measures	measures	measures	measures	$0.6 M	---	---	$0.2 M	---	---	measures	measures	measures	measures	$ TBD	$1.2 M	measures	measures
South	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	Corridor damage	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	Reconstruct corridor	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(454 acres)	*Cost*	$4.8 M	measures	measures	measures	measures	measures	measures	$4.8 M	---	---	$1.7 M	---	$ TBD	measures	measures	measures	measures	$ TBD	$9.6 M	measures	measures
Total (1,570 ac.)	$50.9 M plus TBD	$9.8 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$11.7 M	$0.0 M	$1.7 M	$4.3 M	$0.0 M	$ TBD	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$ TBD	$23.4 M	$0.0 M	$0.0 M

TRANSPORTATION IMPACT MATRIX - CITY OF TUKWILA

PLATE 8.5

NEIGHBORHOOD		CONGESTION							PHYSICAL DAMAGE				CONSTRUCTION IMPACTS							POST-CONSTRUCTION IMPACTS		
NAME	MEASURES	LEVEL OF SERVICE (LOS)	ACCIDENTS	SCHOOL BUS OPERATIONS	TRANSIT BUS OPERATIONS	POLICE & EMERGENCY VEHICLE ACCESS	PARKING & PEDESTRIAN ACCESS	TRAFFIC NOISE	LOCAL STREETS	STATE ROADS	STATE BRIDGES	INCREASED MAINTEN./ RECONSTRUC.	TRUCK HAUL ROUTES	BARGE/RAIL CONVEYOR SYSTEM	TRAFFIC DIVERSION	TRAFFIC CONTROL	CONSTRUCT. STAGING/ PHASING	WORK-FORCE TRAFFIC	CONCURRENT CONSTRUC. PROJECTS	ADDITIONAL TRAFFIC	INCREASED OPERATION/ MAINTENANCE COSTS	MASTER PLAN UPDATE
Ryan	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	---	Road damage	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	---	Reconstruct roads	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(114 acres)	*Cost*	$0.8 M	measures	measures	measures	measures	measures	measures	---	$0.3 M	---	$0.1 M	---	---	measures	measures	measures	measures	$ TBD	$0.6 M	measures	measures
Allentown	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	---	Road damage	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	---	Reconstruct roads	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(346 acres)	*Cost*	$4.0 M	measures	measures	measures	measures	measures	measures	---	$1.2 M	---	$0.3 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$2.4 M	measures	measures
Cascade View	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	---	---	Pavement damage	---	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	---	---	Increase maint.	---	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(303 acres)	*Cost*	$1.1 M	measures	measures	measures	measures	measures	measures	$1.1 M	---	---	$0.3 M	---	---	measures	measures	measures	measures	$ TBD	$2.2 M	measures	measures
Foster	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(485 acres)	*Cost*	$1.5 M	measures	measures	measures	measures	measures	measures	$1.7 M	$1.3 M	$6.8 M	$0.9 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$6.0 M	measures	measures
Thorndyke	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(420 acres)	*Cost*	$4.3 M	measures	measures	measures	measures	measures	measures	$3.0 M	$1.5 M	$3.4 M	$1.3 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$9.0 M	measures	measures
Tukwila Hill	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(857 acres)	*Cost*	$4.9 M	measures	measures	measures	measures	measures	measures	$2.1 M	$2.0 M	$3.4 M	$1.2 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$8.2 M	measures	measures
McMicken	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(461 acres)	*Cost*	$1.0 M	measures	measures	measures	measures	measures	measures	$0.3 M	$1.5 M	---	$0.5 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$3.6 M	measures	measures
M.I.C.	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(1,083 ac.)	*Cost*	$8.6 M	measures	measures	measures	measures	measures	measures	$5.1 M	$1.5 M	$1.7 M	$1.9 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$13.2 M	measures	measures
Riverton	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	---	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	---	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(276 acres)	*Cost*	$3.8 M	measures	measures	measures	measures	measures	measures	$1.9 M	$0.7 M	---	$0.8 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$5.2 M	measures	measures
CBD	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(1,095 ac.)	*Cost*	$11.1 M	measures	measures	measures	measures	measures	measures	$10.1 M	$1.3 M	$3.4 M	$3.2 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$22.6 M	measures	measures
Tukwila Valley South	*Impact*	Traffic congestion	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Mitigated	Road damage	Road damage	Bridge damage	Pavement damage	Increased truck traffic	---	Mitigated	Mitigated	Mitigated	Mitigated	Regional traffic	Additional traffic	Mitigated	Mitigated
	Mitigation	Corridor improve's.	by LOS	by LOS	by LOS	by LOS	by LOS	by LOS	Reconstruct roads	Reconstruct roads	Replace bridges	Increase maint.	Traffic control	---	by LOS	by LOS	by LOS	by LOS	Transp. manage. plan	Corridor improve's.	by LOS	by LOS
(367 acres)	*Cost*	$2.6 M	measures	measures	measures	measures	measures	measures	$2.0 M	$0.3 M	$1.7 M	$0.7 M	$50,000/year per location	---	measures	measures	measures	measures	$ TBD	$4.6 M	measures	measures
Total (5,807 ac.)	$191.7 M plus TBD	$43.7 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$27.2 M	$11.6 M	$20.4 M	$11.2 M	$50,000/year per location	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$0.0 M	$77.6 M	$0.0 M	$0.0 M

TRANSPORTATION IMPACT MATRIX - PUBLIC FACILITIES

PLATE 8.6

School/Hospital (Neighborhood)		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle access	Parking & pedestrian access	Traffic Noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construc. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
Highline School/Hospital Facilities in City of Burien																						
Highline Community Hospital (Gregory Heights)	Impact	---	---	---	---	---	---	---	See Gregory Heights (Plate 8.1)	---	---	See Gregory Heights (Plate 8.1)	See Gregory Heights (Plate 8.1)	---	---	---	---	---	See Gregory Heights (Plate 8.1)	---	---	---
	Mitigation	---	---	---	---	---	---	---		---	---			---	---	---	---	---		---	---	---
	Cost	---	---	---	---	---	---	---		---	---			---	---	---	---	---		---	---	---
Gregory Heights Elementary School (Gregory Heights)	Impact	---	---	---	---	---	---	---	See Gregory Heights (Plate 8.1)	---	---	See Gregory Heights (Plate 8.1)	See Gregory Heights (Plate 8.1)	---	---	---	---	---	See Gregory Heights (Plate 8.1)	---	---	---
	Mitigation	---	---	---	---	---	---	---		---	---			---	---	---	---	---		---	---	---
	Cost	---	---	---	---	---	---	---		---	---			---	---	---	---	---		---	---	---
Sylvester Middle School (Gregory Heights)	Impact	---	---	---	---	---	---	---	See Gregory Heights (Plate 8.1)	---	---	See Gregory Heights (Plate 8.1)	See Gregory Heights (Plate 8.1)	---	---	---	---	---	See Gregory Heights (Plate 8.1)	---	---	---
	Mitigation	---	---	---	---	---	---	---		---	---			---	---	---	---	---		---	---	---
	Cost	---	---	---	---	---	---	---		---	---			---	---	---	---	---		---	---	---
Hazel Valley Elementary School (Downtown)	Impact	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	---	---	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	---	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)	See Down-town (Plate 8.1)
	Mitigation									---	---			---								
	Cost									---	---			---								
Salmon Creek Elementary School (North Central)	Impact	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	---	---	See North Central (Plate 8.1)	See North Central (Plate 8.1)	---	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)	See North Central (Plate 8.1)
	Mitigation									---	---			---								
	Cost									---	---			---								
Seahurst Elementary School (Seahurst)	Impact	---	---	---	---	---	---	---	See Seahurst (Plate 8.1)	---	---	See Seahurst (Plate 8.1)	See Seahurst (Plate 8.1)	---	---	---	---	---	See Seahurst (Plate 8.1)	See Seahurst (Plate 8.1)	---	---
	Mitigation	---	---	---	---	---	---	---		---	---			---	---	---	---	---			---	---
	Cost	---	---	---	---	---	---	---		---	---			---	---	---	---	---			---	---
Shorewood Elementary School (Shore-wood)	Impact	See Shorewood (Plate 8.1)	See Shore-wood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	---	---	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	---	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)
	Mitigation									---	---			---								
	Cost									---	---			---								
Marine Tech Lab. (Shore-wood)	Impact	See Shorewood (Plate 8.1)	See Shore-wood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	---	---	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	---	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)	See Shorewood (Plate 8.1)
	Mitigation									---	---			---								
	Cost									---	---			---								
Cedarhurst Elementary School	Impact	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	---	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)	See North East (Plate 8.1)
	Mitigation													---								
	Cost													---								
Sunnydale Elementary School (East Central)	Impact	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	---	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)
	Mitigation													---								
	Cost													---								
Highline High School (East Central)	Impact	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	---	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)	See East Central (Plate 8.1)
	Mitigation													---								
	Cost													---								
Highline School/Hospital Facilities in City of Des Moines																						
Des Moines Elementary School (West Central)	Impact	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	---	---	See West Central (Plate 8.2)	---	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)
	Mitigation									---	---		---									
	Cost									---	---		---									

TRANSPORTATION IMPACT MATRIX - PUBLIC FACILITIES (continued)

School/Hospital (Neighborhood)		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle access	Parking & pedestrian access	Traffic Noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construc. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
Highline School/Hospital Facilities in City of Des Moines (continued)																						
Olympic Elementary School (West Central)	Impact	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	---	---	See West Central (Plate 8.2)	---	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)	See West Central (Plate 8.2)
	Mitigation									---	---		---									
	Cost									---	---		---									
Midway Elementary School (East Central)	Impact	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	---	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)
	Mitigation												---									
	Cost												---									
Pacific Middle School (East Central)	Impact	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	---	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)
	Mitigation												---									
	Cost												---									
Mount Rainier High School (East Central)	Impact	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	---	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)	See East Central (Plate 8.2)
	Mitigation												---									
	Cost												---									
North Hill Elementary School (North Hill)	Impact	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	---	---	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	---	---	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)	See North Hill (Plate 8.2)
	Mitigation									---	---			---	---							
	Cost									---	---			---	---							
Parkside Elementary School (South Des Moines)	Impact	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	---	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	---	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)	See South Des Moines (Plate 8.2)
	Mitigation										---			---								
	Cost										---			---								
Highline School/Hospital Facilities in City of Normandy Park																						
Marvista Elementary School (South)	Impact	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	---	---	See South (Plate 8.4)	---	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)	See South (Plate 8.4)
	Mitigation									---	---		---									
	Cost									---	---		---									
Highline School/Hospital Facilities in City of SeaTac (outside study area)																						
Bow Lake Elementary School (SeaTac)	Impact	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation																					
	Cost																					
Madrona Elementary School (SeaTac)	Impact	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation																					
	Cost																					
McMicken Heights Elementary School (SeaTac)	Impact	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation																					
	Cost																					
Valley View Elementary School (SeaTac)	Impact	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation																					
	Cost																					
Chinook Middle School (SeaTac)	Impact	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
	Mitigation																					
	Cost																					

TRANSPORTATION IMPACT MATRIX - PUBLIC FACILITIES (continued)

PLATE 8.6 (continued)

School/Hospital (Neighborhood)		Congestion							Physical Damage				Construction Impacts							Post-Construction Impacts		
Name	Measures	Level of service (LOS)	Accidents	School bus operations	Transit bus operations	Police & emergency vehicle access	Parking & pedestrian access	Traffic Noise (LEQ)	Local streets	State roads	State bridges	Increased mainten./ reconstruc.	Truck haul routes	Barge/rail conveyor system	Traffic diversion	Traffic control	Construct. staging/ phasing	Work-force traffic	Concurrent construc. projects	Additional traffic	Increased operation/ maintenance costs	Master plan update
Highline School/Hospital Facilities in City of SeaTac (continued)																						
Tyee High School (SeaTac)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Sea-Tac Occupational Skill (SeaTac)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Highline School/Hospital Facilities in City of Seattle (outside study area)																						
Hilltop Elementary School (Seattle)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Mount View Elementary School (Seattle)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Riverton Heights Elementary School (Seattle)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Southern Heights Elementary School (Seattle)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Cascade Middle School (Seattle)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Evergreen High School (Seattle)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Highline School/Hospital Facilities in Unincorporated King County (outside study area)																						
Beverly Park Elementary School (County)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
White Center Elementary School (County)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Satellite Alternate High School (County)	Impact / Mitigation / Cost	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area	Outside Study Area
Total																						

APPENDIX C
PROJECT CONTACTS

City Council Members/Staff
City of Burien, Washington
City of Des Moines, Washington
City of Federal Way, Washington
City of Normandy Park, Washington
City of SeaTac, Washington
City of Tukwila, Washington

Colorado Springs International Airport
Bob Allison, Assistant Director of Aviation

Dallas/Fort Worth International Airport
Karen Robertson, Noise Abatement Officer
Dana Ryan, Senior Airport Planner

King County Ground Water Management Program
Mark Isaacson
Paul Shallow

King County Surface Water Management Division
David Masters

Lambert Field/St. Louis International Airport
Jerry Tinnea, Noise Abatement Officer

Miller Creek Management Coalition
Clark Dodge

Minneapolis/St. Paul International Airport
Nigel Finney, Deputy Executive Director/Planning & Environment

Normandy Park Community Club
Shawn McEvoy

Port of Seattle
Marsha Holbrook
Bob Wells

Puget Sound Air Pollution Control Agency
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San Diego International Airport
Nile Marmion, Airport Noise Specialist
Jeanette Lake, Director of Noise Information

San Francisco International Airport
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State of Washington, Department of Community, Trade and Economic Development
Steve Wells, Director
Sandra L. Benbrook, PHD, Assistant Director

State of Washington, Department of Ecology
Doug Brown
Paul Carr
Erik Stockdale

State of Washington, Department of Fish and Wildlife
Ted Muller

State of Washington, Department of Transportation
Bill Dues
Robert Josephson
David McCormick
Renee Montgelas
Craig Stone
Samuel Teitzel

Synergy Consultants, Inc.
Mary Vigilante, President

Trout Unlimited
Al Miller

US Department of Transportation
John D'Aprile
Gregg Fleming

Waste Action Project
Greg Wingard

Other
Airport Impact Assistance Executive Committee
City of Burien Planning Commission
Highline School District
Regional Council on Airport Affairs

SECTION 9

POTENTIAL SOCIO-ECONOMIC IMPACTS AND MITIGATION

SECTION 9
POTENTIAL SOCIO-ECONOMIC IMPACTS AND MITIGATION

9.01 - EXPECTED CHANGES IN LAND VALUES, LAND USES, HOME OWNERSHIP TENURE, LOCAL GOVERNMENT REVENUE AND SOCIAL SERVICE NEEDS RESULTING FROM CONSTRUCTION OF THE THIRD RUNWAY AND RELATED FACILITIES

Aircraft operations at Sea-Tac International Airport impact the value of close-by properties in two ways.

First, the Airport's operations depress property values below the level that real estate markets would produce if the Airport did not exist. If a single-family residential house located in, for example, Burien could be physically transported to an identical location on an identical lot in another part of King County, its value would be increased, and the amount of its increase is the depression in value caused by proximity to the Airport. Section 9.02 estimates the average loss in value of real estate locate in close proximity to Sea-Tac International Airport by comparing a large sample of comparable single-family housing units in Northwest and Southwest King County holding constant the non-Airport factors that also influence real estate values.

A second way in which Sea-Tac International Airport operations impact the value of real estate is in the variation in value among properties caused by their proximity to the flight paths of arriving and departing aircraft. Such changes are the "shadow" affects (noise pollution, visual pollution, possible air quality pollution, and a generally degraded environment for human habitat) caused by living under low-flying aircraft. Section 9.03 uses a statistical technique known as regression analysis to estimate Sea-Tac International Airport's shadow affects by measuring the difference in value of a property, holding other things the same, when it is located at different distances from directly under one of Sea-Tac International Airport's arrival/departure flight paths.

The remaining subsections provide information on the changes in land use produced by Airport-induced depressions in adjacent land values, and the alteration in the demographic profile of persons living in jurisdictions where depressed land values result in altered land uses.

It is important to remember that the following analysis addresses the issue of depressed but not declining land values. All parts of the Puget Sound Region have experienced population growth in the recent past, and the entire Puget Sound Region is expected to experience rates of population growth above the national average in the foreseeable future. This means that the Puget Sound Region is expected to have significant net in-migration. As a result, average real estate values in the region will undoubtedly rise. Real estate located in close proximity to the Airport will participate in these growth trends and will also experience rising land values.

Because of the Airport, however, the rate of appreciation in the value of close-by real estate is expected to be less than it otherwise would have been. The correct measure of the Airport-induced depression in land values, consequently, is the price difference between comparable properties located close too and distant from the Airport. Neither a simple calculation of whether or not property values have increased nor a comparison of properties inside or outside any specific LDN contour line provides an appropriate basis for comparison.

9.02 - AIRPORT IMPACTS ON AVERAGE PROPERTY VALUES

The impact of proximity to the Airport was evaluated using average property values for comparable housing units in ten Census Tracts in Southwest King County immediately around Sea-Tac International Airport and ten Census Tracts in Northwest King County - the area that generally conforms to the City of Shoreline.

Northwest King County was chosen for comparison based on the following criteria:

- The Census Tracts are all located in King County and are equally affected by County and State land use and development policies.
- The Census Tracts are all bordered by Puget Sound to the west and Lake Washington to the east.
- Both clusters of Census Tracts contain commercial areas bordering Highway 99, and both have a mix of residential areas ranging from low/moderate income to high/ upper income.
- Both clusters of Census Tracts contain racially and ethnically diverse populations.

The cluster of ten Census Tracts around the Airport contained 17,046 housing units in 1990, of which 11,526 (67.6%) were single-family. The cluster of ten Census Tracts in Northwest King County contained 19,523 housing units in 1990, of which 12,683 (65.0%) were single-family.

The following parameters were used to screen housing units in the two clusters of Census Tracts for comparability:

- Only units rated as being in "Very Good" condition by the King County Assessors office were included.
- All units with a "View" were excluded.
- All units were in "Single-Family ' zoned areas and were classified as single-family land uses.
- All units had an above ground structure of 1,000 square feet or more.

- All units were located on lots of between 10,000 and 14,999 square feet.
- All units had three or more bedrooms.
- All units had two or more bathrooms.

These screening criteria excluded the top and the bottom of the distribution of housing units in both areas and resulted in a total of 739 of the 11, 526 single-family properties (6.4%) in the ten Census Tracts around the Airport (Southwest King County) and 760 of the 12,683 single-family properties (6.0%) in ten Census Tracts in Northwest King County being used for comparison of real estate values. Summary statistics from the King County Assessors Office for these units are contained in Table 9.01.

Table 9.01
Comparison of Housing Units in Northwest and Southwest King County - 1993

	SW mean value	NW mean value	Difference (SW-NW)	Percent Difference
Size				
Lot size	11,914 sq. ft.	11,522 sq. ft.	+392 sq. ft.	3.3%
Above ground structure size	1,538 sq. ft.	1,507 sq. ft.	-31 sq. ft.	-2.0%
Rooms				
Number of bedrooms	3.6	3.6	0	-1.4%
Number of bathrooms	2.0	2.0	0	0.6%
Value				
Assessed value of land	$52,734	$60,181	-$7,447	-14.1%
Assessed value of structure	$88,703	$95,550	-$6,847	-7.7%
Total assessed value	$141,438	$155,731	-$14,294	-10.1%

(Source: King County Assessors Office)

The two groups of properties compared closely in terms of their physical attributes. The difference in average lot size between the Southwest and Northwest King County properties was 3.3%. The difference in size of structure was 2.0%, in number of bedrooms 1.4%, and in number of baths 0.6%. In terms of property values however the differences were more pronounced. Average assessed value of land was 14.1% higher in Northwest King County than it was in areas immediately surrounding the Airport, and assessed value of structures was 7.7% higher. The assessed value of land and structures combined was 10.1% higher.

Standardized for view, condition of structure, size of structure, lot size, number of bedrooms, number of baths, zoning, land use, county/state development policies, and similarity of neighborhoods, a housing unit selling for $141,400 in the immediate vicinity of the Airport would sell for $155,700, or $14,300 (10. I%) more, if it were located elsewhere.

The average difference of 10.1% in the assessed value of real estate (property plus structure) when all other factors are adjusted for is attributable to the impact of low flying aircraft in the immediate vicinity of Sea-Tac International Airport. The resulting depression of property values as of 1993, taking account of community differences is shown in Table 9.02.

Table 9.02
Estimated Average Depression in Single-Family Residential Property Values, by Community - 1993

Community	Actual Average Assessed Value of Housing Unit	Estimated Assessed Value Without Airport	Difference
Burien	$129,900	$143,000	-$13,100
Des Moines	$136,100	$149,800	-$13,700
Federal Way	$142,900	$157,300	-$14,400
Normandy Park	$173,600	$191,100	-$17,500
Tukwila	$122,400	$134,800	-$12,400

Between 1993 and the Year 2000, operations at Sea-Tac International Airport are forecast to increase by 39,700, or 11.7%. Between the Years 2000 and 2020, operations are forecast to increase by an additional 62,400, or 16.5%. Applying these same rates of change to the estimated 1993 difference in single-family residential property values caused by aircraft operation at Sea-Tac International Airport produces the depressed values shown in Table 9.03. The next to the last column of Table 9.03 contains the expected reduction of value for the average single-family residential housing unit between the Years 2000 and 2020. The last column shows the average difference in value experienced over the entire 20-year period 2000 through 2020.

There will be no reduction in property value attributable to the Sea-Tac International Airport expansion until the Year 2000. The decline will be small the first year since there will be few operations over the Airport's annual service volume (ASV). As operations over the ASV threshold increase, the relative decline in property value will increase, reaching, in the case of Burien, $36,356 in the Year 2020. Averaged over the entire 20-year period, the yearly decline is $13,179, as shown in the last column of Table 9.03.

This loss of value occurs after Sea-Tac International Airport would have reached its ASV capacity limit had the Third Runway and related facility improvements not been built.

Table 9.03
Forecast of Average Depression in Single-Family Residential Property Values Caused by Aircraft Operations at Sea-Tac

Community	1993	2000	2020	Change 2000 - 2020	Average Yearly Difference 2000-2020
Burien	-$13,100	-$29,831	-$56,187	-$26,356	-$13,179
Des Moines	-$13,700	-$31,227	-$58,835	-$27,609	-$13,804
Federal Way	-$14,400	-$32,804	-$61,795	-$28,891	-$14,496
Normandy Park	-$17,500	-$39,859	-$75,079	-$35,221	-$17,610
Tukwila	-$12,400	-$28,172	-$53,016	-$24,844	-$12,422

9.03 - FLIGHT TRACK IMPACTS ON AVERAGE PROPERTY VALUES

The impact on a parcel's value of its location under, or in close proximity to, the approach/ departure flight track of aircraft operating at Sea-Tac International Airport was estimated using the linear regression model:

$$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10}$$

where:

Y = assessed value of land and structures
X_1 = lot size (sq. ft.)
X_2 = structure size (sq. ft.)
X_3 = number of bedrooms
X_4 = number of baths
X_5 = distance from center of a jet flight track (east of runway 16/34R or west of runway 16/34L), measured in tenths of a mile.
X_6 = a binary variable representing the City of Des Moines
X_7 = a binary variable representing the City of Normandy Park
X_8 = a binary variable representing the City of SeaTac
X_9 = a binary variable representing Unincorporated King County
X_{10} = a binary variable representing the City of Tukwila

The model's parameters were estimated from Assessors data on 3,026 properties in ten Census Tracts in the immediate vicinity of the Airport. The regression coefficient (adjusted R^2) was 0.65.

The model initially contained variables for the Cities of Federal Way and Kent, but these places had too few cases to be meaningful and were dropped from the final model, The distance from each parcel to the center of the Airport was also initially used as a variable but its coefficient was not statistically significant and it was also dropped from the final model. The following housing units were excluded in estimating the regression model - units with fewer than three bedrooms; units whose condition was less than "good" or "very good"; units with a view; and units not in single-family residential zoned areas. The ratio of the regression's standard error to the standard deviation of the dependent variable was 0.59. The log likelihood ratio was -35,379, and the F-statistic was 566. The Durbin-Watson statistic was 1.44.

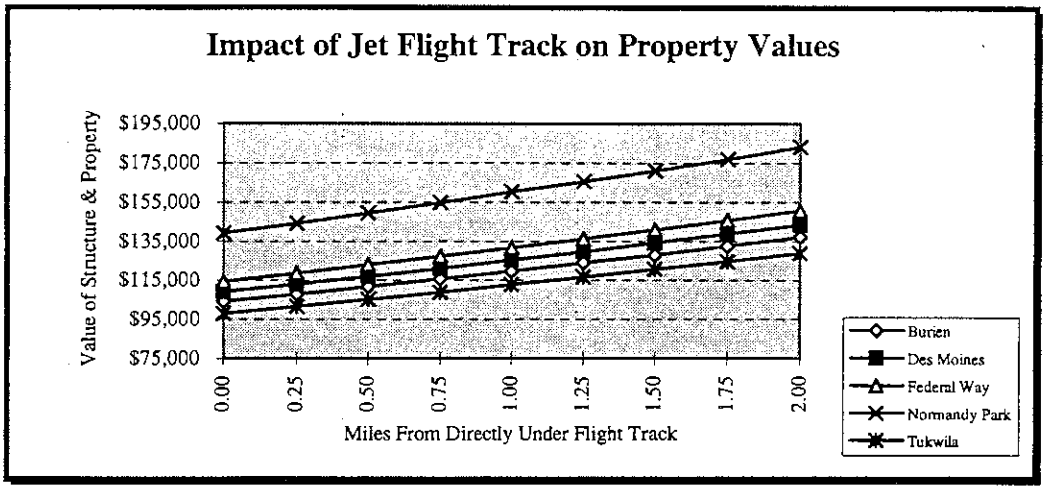
All of the independent variables in the model were statistically significant at the 90% level and seven were statistically significant at the 99% level. The variable measuring a property's distance from a flight track was significant at the 99% level.

The coefficient on the variable for distance from a jet aircraft flight track was 17,784, meaning that. all other things remaining equal, the value of a house and lot increases by about 3.4% ($4,450 on the average valued house of $129,900) for every quarter of a mile the house is farther away from being directly underneath the flight track of departing/approaching jet aircraft. This relationship is shown in Table 9.04 and illustrated in Figure 9.01.

Table 9.04
Model Estimated Impact of Jet Flight Track on Average Property Values

Miles from flight track	Average Value Structure & Property, By Community				
	Burien	Des Moines	Federal Way	Normandy Park	Tukwila
0.00	$104,151	$109,122	$114,574	$139,189	$98,138
0.25	$107,843	$112,990	$118,636	$144,123	$101,617
0.50	$111,666	$116,996	$122,841	$149,232	$105,210
0.75	$115,625	$121,143	$127,196	$154,522	$108,949
1.00	$119,724	$125,438	$131,705	$160,000	$112,811
1.25	$123,822	$129,732	$136,214	$165,478	$116,673
1.50	$128,062	$134,174	$140,878	$171,143	$120,668
1.75	$132,446	$138,767	$145,701	$177,002	$124,799
2.00	$136,980	$143,518	$150,689	$183,062	$129,072

Figure 9.01



9.04 - OPERATIONS IMPACTS ON RESIDENTIAL PROPERTY TAX REVENUES

The *Sea-Tac Master Plan Update Final EIS*'s estimate of reduced residential property tax revenues caused by construction of the Third Runway and related facility improvements is shown in Table 9.05.

The only cause of reduced revenues identified in the Final EIS is the acquisition of property now on the tax tolls of the Cities of Burien and SeaTac. The EIS assumes there will be no impact on land located in the immediate vicinity of the Airport or under the flight track of the Airport's increased traffic volumes. In other words, the Final EIS assumes that unless land is acquired it will not be affected.

Table 9.05
EIS Estimate of Third Runway Induced Decline in Residential Property Tax Revenues

Jurisdiction	Property Tax Rate Per $1,000 Assessed Value	Reduction in Residential Property Tax Revenues
City of Burien	$3.00838	$45,867
City of SeaTac	$3.02811	$181,687
Total		**$227,554**

(Source: US Department of Transportation, Federal Aviation Administration, and Port of Seattle, February 1996, Final EIS, page IV.8-12)

As discussed earlier, construction of the Third Runway and related facilities improvements will allow aircraft operations at the Airport to increase after the Year 2000 - when it reaches its ASV capacity limit - by 62,400, or over 16%. A statistical analysis of comparable properties in King County demonstrates that these increased operations will:

- On average, depress all property values around the Airport below levels they would have had if the aircraft didn't expand; and,

- Specifically, cause a depression of value for properties directly under, and up to two miles on either side of, jet aircraft approach/departures tracks.

The depression of property values below the market levels that would otherwise occur also depresses the flow of property tax revenues to local, county, special purpose, and state governments.

The methodology used to estimate the reduction in single-family residential property tax revenues resulting from Airport impacts that depress property values is as follows. The number of single-family residential housing units in each impacted community was multiplied by the average loss (depression) of value per unit for each community between the Years 2000 and 2020 to estimate the aggregate loss of property value. Each city's total levy rate (regular and fire) was multiplied by its aggregate loss of property value to estimate the loss of single-family residential property taxes. The number of single-family housing units in each city was obtained from the Office of Financial Management's Forecasting Division. The average yearly increase in each city's single-family residential housing units between 1990 and 1995 was used to trend forward its stock of single-family housing.

Levy rates for each city were obtained from the King County Assessors Office's Accounting Division. The estimated property value loss by community for the Years 2000, 2010 and 2020 and the cumulative property losses between 2000 and 2020 are shown in Table 9.06.

In the Year 2000, after which the increase in aircraft operations at Sea-Tac International Airport will be the result of construction of the Third Runway and related facilities improvements, the five impacted cities will experience depressed property values for single-family residential housing units estimated of approximately $1.7 million. As Sea-Tac International Airport operations increase, the depression of property values in the impacted communities will grow each year, reaching $2.2 million in the Year 2020. Over the 20-year period, 2000 through 2020, the cumulative loss of property tax revenues in the five impacted cities is estimated at approximately $38.8 million (expressed in constant value 1995 dollars), distributed among the cities as follows:

- Burien $14.2 million
- Des Moines $6.4 million
- Federal Way $11.6 million
- Normandy Park $2.8 million
- Tukwila $3.7 million

Table 9.06
Single-Family Residential Property Tax Revenue Losses by Housing Units in Five Impacted Cities in Immediate Proximity of the Airport

Community	Forecast Year 2000	2010	2020
Burien			
Number of impacted housing units	15,890 DU	17,890 DU	19,890 DU
Average loss of value per DU	-$13,179	-$13,179	-$13,179
Estimated total loss of value	-$209,411,749	-$235,769,426	-$262,127,104
City property tax levy rate	0.00300969	0.00300969	0.00300969
Yearly revenue loss	-$630,264	-$709,593	-$788,921
Cumulative revenue loss	-$630,264	-$6,699,287	-$14,191,858
Des Moines			
Number of impacted housing units	5,179 DU	6,179 DU	7,179 DU
Average loss of value per DU	-$13,804	-$13,804	-$13,804
Estimated total loss of value	-$71,492,950	-$85,297,343	-$99,101,736
City property tax levy rate	0.00374534	0.00374534	0.00374534
Yearly revenue loss	-$267,765	-$319,468	-$371,170
Cumulative revenue loss	-$267,765	-$2,936,165	-$6,389,351
Federal Way			
Number of impacted housing units	10,992 DU	12,392 DU	13,792 DU
Average loss of value per DU	-$14,496	-$14,496	-$14,496
Estimated total loss of value	-$159,334,980	-$179,628,737	-$199,922,493
City property tax levy rate	0.00323195	0.00323195	0.00323194
Yearly revenue loss	-$514,963	-$580,551	-$646,138
Cumulative revenue loss	-$514,963	$5,477,569	-$11,611,022
Normandy Park			
Number of impacted housing units	2,417 DU	2,577 DU	2,737 DU
Average loss of value per DU	-$17,610	-$17,610	-$17,610
Estimated total loss of value	-$42,564,077	-$45,381,724	-$48,199,371
City property tax levy rate	0.00310000	0.00310000	0.00310000
Yearly revenue loss	-$131,949	-$140,683	-$149,418
Cumulative revenue loss	-$131,949	-$1,363,160	-$2,813,667
Tukwila			
Number of impacted housing units	3,666 DU	4,866 DU	6,066 DU
Average loss of value per DU	-$12,422	-$12,422	-$12,422
Estimated total loss of value	-$45,539,453	-$60,445,984	-$75,352,516
City property tax levy rate	0.00310000	0.00310000	0.00310000
Yearly revenue loss	-$141,172	-$187,383	-$233,593
Cumulative revenue loss	-$141,172	-$1,642,774	-$3,747,651
Yearly Revenue Loss All Cities	**-$1,686,113**	**-$1,937,677**	**-$2,189,239**
Cumulative Revenue Loss All Cities	**-$1,686,113**	**-$18,118,955**	**-$38,753,549**

(Source: Office of Financial Management, King County Assessor's Office.)

9.05 - FLIGHT TRACK IMPACTS ON RESIDENTIAL PROPERTY TAX REVENUES

In addition to the loss of value resulting from aircraft operations that will affect all single housing units in immediate proximity to the Airport, single-family housing units that will be under the flight tack of approaching/departing aircraft using the proposed Third Runway will suffer additional value losses from having low flying aircraft pass directly overhead. The magnitude of these types of impacts were described and analyzed in Section 9.03, above. The methodology used to estimate the flight track impacts on the property tax revenues of the affected cities was as follows.

Approaches/departures using the Third Runway will create a flight track approximately half a mile to the west of the flight track on existing runway 16/34L. A new set of single-family housing units will lie directly under the flight track (defined as 1/8th of a mile on either side) and a new set of units will fall within the quarter mile and half mile bands to the west of the Third Runway s new flight track. To the south, the affected single-family housing units will be in Des Moines Federal Way and Normandy Park (only the half mile band will impact Normandy Park). To the North, the new Third Runway flight track will pass over the City of Burien. The City of Tukwila lies entirely to the east of the Airport and will not be impacted by the flight track generated by the Third Runway.

The linear north-south distance of the new flight track for the Third Runway was calculated for each of the impacted cities. Each flight track "impact band" used in the regression model (Section 9.03) was a quarter-mile wide.

The linear distance of the Third Runway's flight track over each impacted city multiplied by a quarter mile therefore generated an estimate of the area of each impact band within each city. The average lot size of single-family residential housing units used to calibrate the regression model was 12,950 square feet. Using this average lot size produces an estimate of 538 single-family housing units for each linear mile of the new flight track.

Multiplying this estimate by the dollar value of the average annual depression in single-family housing units for each city produced the estimated total value reduction in single-family residential housing units as a result of the Third Runway's value loss gradient. Multiplying the loss of value by each city's property tax levy rate produced the estimate of annual property tax revenue loss for each city. The results are summarized in Table 9.07

In the five impacted cities combined, tax collections from single-family residential units lying directly under or close to the Third Runway's jet flight tracks will be reduced by $294,260 a year, or $5.89 million (expressed in constant value 1995 dollars) over the 20-year period 2000 to 2020 as a result of depressed property values. The distribution of these cumulative 20-year revenue losses by city are as follows:

- Burien $0.97 million
- Des Moines $2.73 million
- Federal Way $1.78 million
- Normandy Park $0.41 million
- Tukwila $0.00 million

Table 9.07
Average Annual Single-Family Property Tax Revenue Losses Resulting from the Third Runway's Flight Track Gradient

	Burien	Des Moines	Federal Way	Normandy Park	Tukwila
Track Miles by Noise Gradient					
0.00 miles	1.28	2.77	1.99	0.00	0.00
0.25 miles	1.28	2.77	1.99	0.00	0.00
0.50 miles	1.28	2.77	1.99	1.14	0.00
SF DUs/Track Mile	538	538	538	538	538
New Noise Gradient Affected DU					
0.00 miles	688	1,491	1,070	---	---
0.25 miles	688	1,491	1,070	---	---
0.50 miles	688	1,491	1,070	612	---
Average Property Value Loss per DU					
0.00 miles	-$7,551	-$7,874	-$8,267	-$10,043	-$7,081
0.25 miles	-$7,782	-$8,153	-$8,560	-$10,399	-$7,332
0.50 miles	-$8,057	-$8,442	-$8,864	-$10,768	-$7,592
Total Value Loss from Gradient					
0.00 miles	-$5,170,645	-$11,737,775	-$8,848,167	---	---
0.25 miles	-$5,353,943	-$12,153,876	-$9,161,832	---	---
0.50 miles	-$5,543,738	-$12,584,727	-$9,486,616	-$6,585,531	---
Total	-$16,068,326	-$36,476,378	-$27,496,615	- S6,585,531	---
Property tax levy rate	0.00300969	0.00225795	-0.00155887	0.0017	0.00321043
Annual Loss of Property Tax Revenues					
0.00 miles	-$15,562	-$43,962	-$28,597	$0	$0
0.25 miles	-$16,114	-$45,520	-$29,611	$0	$0
0.50 miles	-$16,685	-$47,134	-$30,660	-$20,415	$0
Total	-$48,361	-$136,616	-$88,868	-$11,195	$0

9.06 - SUMMARY OF IMPACTS ON SINGLE FAMILY RESIDENTIAL PROPERTY TAX REVENUES

The total cumulative reduction in single-family property tax revenues during the Years 2000 through 2020 caused by construction and operation of the proposed Third Runway and related Airport facilities in the five impacted cities is shown in Table 9.08. In this table, the flight track-induced relative land value losses are deducted from the operations-induced relative land value losses to prevent double-counting.

Over the 20-year period 2000 through 2020, the five impacted communities will suffer a reduction in property tax revenues from single-family residential units of $39.9 million (expressed in constant value 1995 dollars) as a result of construction of the Third Runway and related Airport improvements. The average annual revenue reduction will be almost $2.0 million.

Table 9.08
Total Loss of Single-Family Residential Housing Property Tax Revenue Caused by Construction and Operation of the Third Runway, Years 2000 through 2020

Community	Total Revenue Losses	Land Acquisition-Induced Losses	Aircraft Operations-Induced Losses	Flight Track Gradient-Induced Losses
Burien	-$15,338,533	-$1,146,675	-$13,224,644	-$967,214
Des Moines	-$6,389,351	$0	-$3,657,022	-$2,732,329
Federal Way	-$11,611,022	$0	-$9,833,668	-$1,777,354
Normandy Park	-$2,813,667	$0	-$2,405,364	-$408,303
Tukwila	-$3,747,651	$0	-$3,747,651	$0
Combined Total Losses	**-$39,900,224**	**-$1,146,675**	**-$32,868,349**	**-$5,885,196**

The largest source of property tax losses (82.3%) will be depressions in property values caused by the increase in Sea-Tac International Airport's aircraft operations after the Year 2000, and made possible by construction of the Third Runway and related Airport improvements. A loss of $32.9 million in local government revenues (expressed in constant value 1995 dollars) over the 20-year period will result. The second largest source of property tax losses (14.8%) will come from the decline in single-family residential property values of units beneath the flight track of aircraft using the proposed Third Runway. These property value reductions will cause a loss of an additional $5.9 million in local government revenues over the 20-year period (again expressed in constant value 1995 dollars).

The smallest cause of local government property tax revenue losses will result from the acquisition of properties required for expansion of the Airport. These reduction (which are the only ones discussed in the Final EIS) will cause a cumulative loss of $1.1 million. The acquisition of properties as part of the Airport's Third Runway related expansion will begin in 1996. Cumulative revenue losses are for a 25-year period 1996 through 2020, inclusive. Looked at in terms of the impacted communities, Table 9.09 contains the percentage distribution of total property tax revenue losses among the impacted cities.

Table 9.09
Distribution of Property Tax Revenue Losses Among Impacted Cities

Community	Cumulative Loss of Property Tax Revenues	Percent of Total
Burien	-$15,338,533	38.4%
Des Moines	-$6,389,351	16.0%
Federal Way	-$11,611,022	29.1%
Normandy Park	-$2,813,667	7.1%
Tukwila	-$3,747,651	9.4%
5-City Combined Total	**-$39,900,224**	**100.0%**

9.07 - IMPACTS ON OWNERSHIP OF SINGLE-FAMILY RESIDENTIAL HOUSING UNITS

Economic theory argues that the relative change (reduction) in single-family residential land values discussed above will lead to tenure changes in the affected single-family housing units. The major expected tenure change is a shift from owner occupied to renter occupied housing as relative housing prices fall. Table 9.10 compares housing tenure in the Sea-Tac International Airport impacted communities with housing tenure in the comparison Census Tracts in Northwest King County.

Table 9.10
Owner and Renter Occupied Single-Family Housing Units
Sea-Tac Impacted and Northwest King County Comparison Communities

	Number	Percent
NW King County Comparison Communities		
Total single-family housing units	12,683	100.0%
Owner occupied units	12,254	96.6%
Renter-occupied units	429	3.4%
Sea-Tac Impacted Communities		
Total single-family housing units	11,526	100.0%
Owner occupied units	9,618	83.4%
Renter-occupied units	1,908	16.6%

(Source: 1990 Census, STF-3)

As the data show, the expectations from economic theory hold true. Renter occupied units in areas immediately surrounding the Airport were 16.6% of total single-family housing. In the comparison areas in Northwest King County, they were only 3.4%. If past trends continue, the percent of single-family housing units in the impacted communities occupied by renters will rise to 20.6% in the Year 2020. About two-thirds of the increase in renter's housing tenure percentage will occur after the Year 2000, and is attributable to construction of the proposed Third Runway and related facilities improvement's at Sea-Tac International Airport.

9.08 - IMPACTS ON COMMUNITY DEMOGRAPHIC PROFILES

In *Washington State Housing Needs and Market Trends: An Overview* (Joshi, et.al., 1989) it was stated that (page 44):

> *"Most low income households are renters...Sixty percent of all Washington households with annual incomes below [75% of state median income] were renters....The average renter is generally younger, more mobile, and has an income half that of the average homeowner."*

Table 9.11 compares the income distribution of owner and renter households.

Table 9.11
Income Distribution of Household Owners and Renters - Washington State

Household Income Status	Total	Owner	Renter
Below 50% State median income	26.3%	17.9%	42.4%
50% to 100% State median income	28.4%	25.1%	34.6%
100% to 165% State median income	23.5%	27.6%	15.7%
Over 165% State median Income	21.8%	29.4%	7.3%
Total	**100.0%**	**100.0%**	**100.0%**

(Source: Washington State Housing Needs and Market Trends)

Among households that own their own home, 43% are below state median income and 18% are below half of the state's median income. Among households that rent their home, 76% are below state median income and 42% are below half the state's median income. Looked at from another perspective, renter households make up 66% of all households in the state but they account for only 17% of households with incomes below the State median.

A regression model developed by the consultant team that relates Washington State Department of Social and Health Services' (DSHS) "county use rates" by county to per capita personal income levels in 1994 indicates that the relationship between income levels and need for public services is statistically significant and has a negative sign - meaning that the need for public services goes up as household incomes (and hence, the percent of owners) fall.

"Use rates" are derived by dividing a county's total DSHS clients, for all types of DSHS services, by the county's total population. Counties where a high percentage of seasonal or transient residents receive DSHS services will have overstated use rates. (Washington State Department of Social and Human Services, Office of Research and Data Analysis, April 1996). The regression models adjusted R^2 was 0.15785, the T-statistic for the per capita personal income variable was 2.6335, the regression's F-statistic was 6.9361.

Although a detailed analysis of the relationship between different types of public service needs and the growth of aircraft operations at Sea-Tac International Airport is beyond the work scope of the current socio-economic analysis, it appears from preliminary analysis of available data that such a relationship exists; and that it is statistically meaningful.

9.09 - THE THIRD RUNWAY'S IMPACT UPON COMMUNITY FACILITIES AND SERVICES

The Third Runway and related Airport facilities, will affect the need for community facilities and services by impacting community demographic profiles in the areas immediately surrounding Sea-Tac International Airport. Many of these communities already have a higher need for community services than other communities in King County - reflecting, in part, past impacts of the Airport. One way to compare community service needs is by using "service use rates" calculated by the Washington State DSHS for ninety-nine largest cities in the state, including 18 cities located (at least in part) in King County.

DSHS provides a variety of services and grants to individuals and families with one or more of the following difficulties:

- Child neglect
- Dependent elderly status
- Alcohol/substance abuse
- Developmental disabilities
- Other long-lasting physical/mental disabilities
- Poverty
- Recent refugee status
- Juvenile criminal offenses

DSHS also provides the services in the following administrative categories to individuals and families having these difficulties:

- Aging & Adult Services Administration (AASA)
- Division of Alcohol & Substance Abuse (DASA)
- Division of Children & Family Services (DCFS)
- Division of Developmental Disabilities (DDD)
- Division of Vocational Rehabilitation (DVR)
- Economic Services Administration (ESA)
- Juvenile Rehabilitation Administration (JRA)
- Medical Assistance Administration (MSA)
- Mental Health Division (MHD)

Each fiscal year, DSHS calculates for each city for which it reports the number of clients served in each of its administrative service categories divided by the city's population. It calls these calculations "service use rates" The most recent rates calculated were for 1994 (Washington State Department of Social and Health Services, Office of Research and Data Analysis, May 1996). The total use rate and the programmatic rates for DCFS, DASA, JRA and ESA are presented in Figures 9.02- 9.06.

In terms of DSHS's rate for its total array of services, Normandy Park and Federal Way were below the average use rate for all DSHS cities in King County. The DSHS use rate for Burien, Des Moines and Tukwila was above the average.

Although Renton was below the county average and Lake Forest Part was above it, the general pattern was for cities in the south county to have rates above the average and cities in the north county to have use rates below the average Figure 9.02. In part, this likely reflects past impacts of the Airport on the quality of life, property values, and the resulting land uses and demographics of south King County communities.

Figure 9.02
DSHS Total Service Use Rate

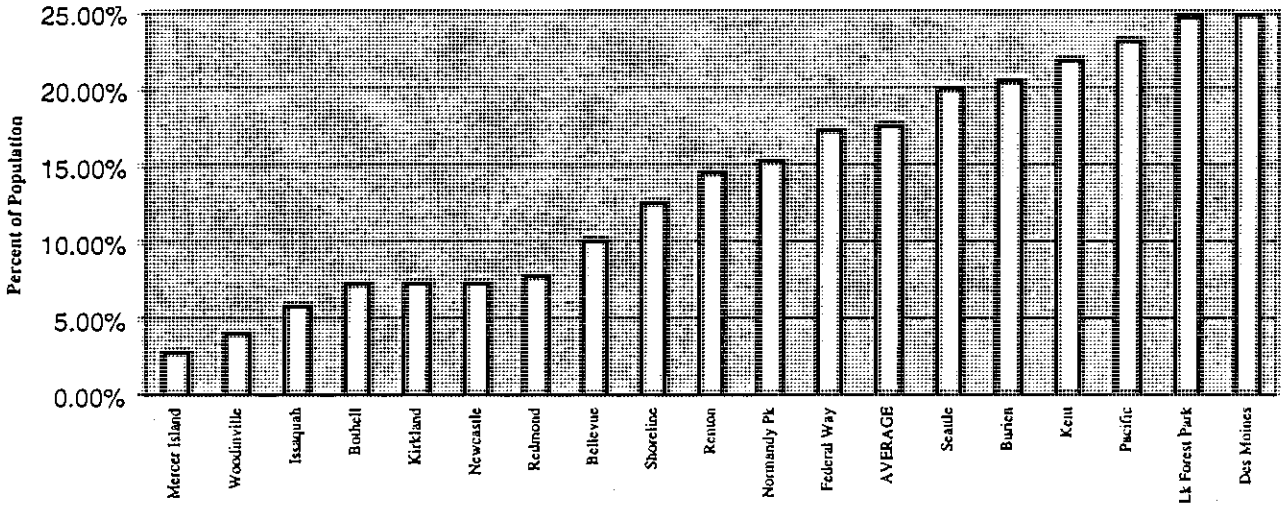
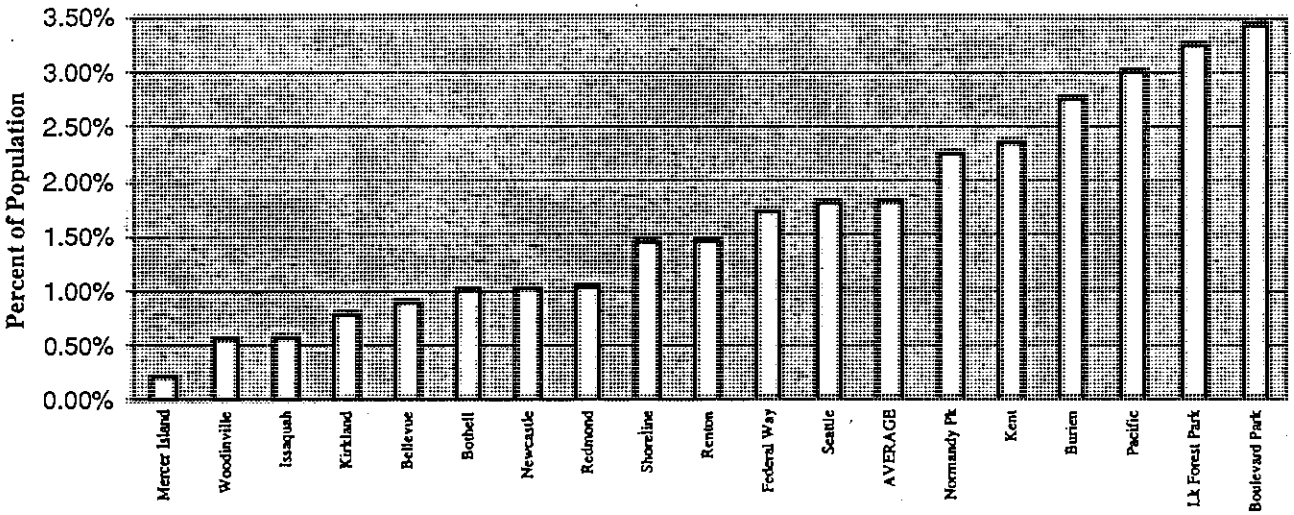


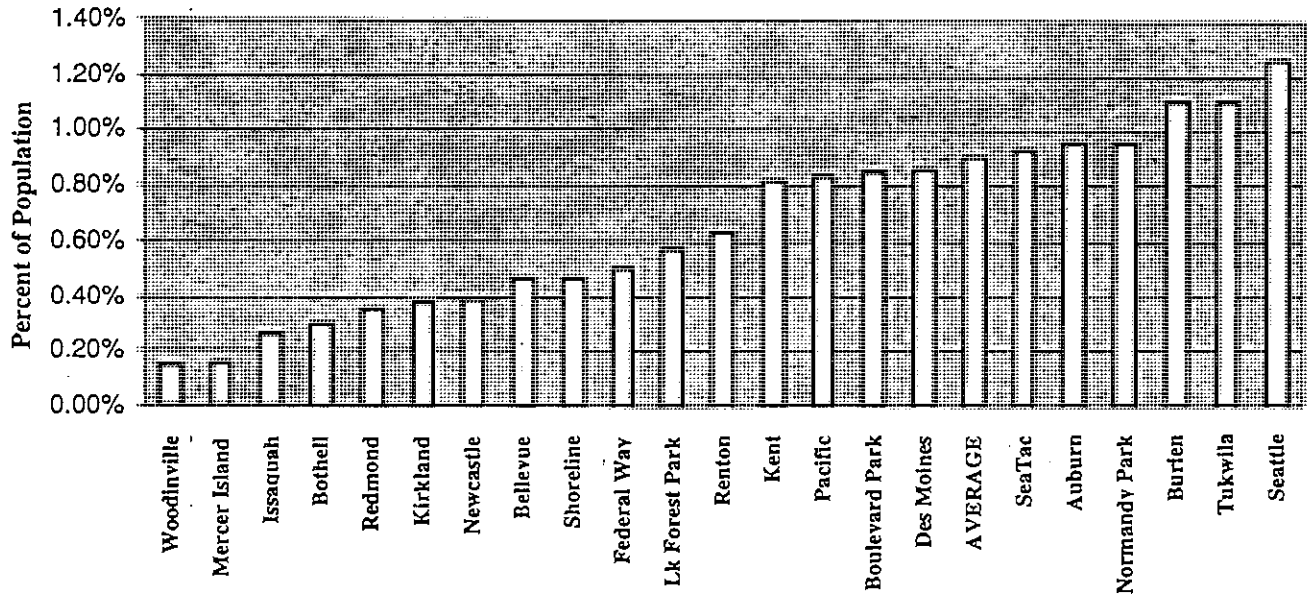
Figure 9.03 shows the use rate for children and family services among King County cities. Federal Way falls below the county average, while Burien, Des Moines, Normandy Park and Tukwila fall above the county's average use rate. Tukwila has the highest DCFS use rate in King County at 3.8%. (The county average was calculated by weighting each city by its population. The weighted total use rate average, for example, was 17.64% while the unweighted average was 16.19%.)

Figure 9.03
DSHS Child & Family Services Use Rates



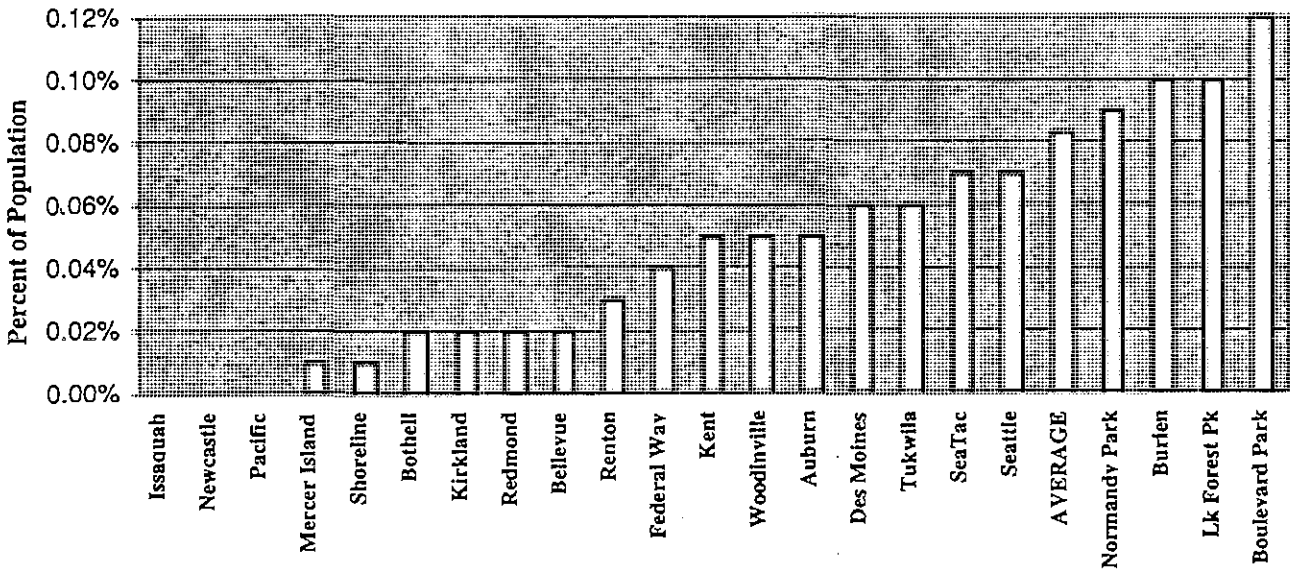
The city alcohol and substance abuse rates are shown in Figure 9.04. Federal Way and Des Moines have rates below the King County average, and Burien, Normandy Park and Tukwila have rates above the county average. To some extent, the DASA use rates reflect the location of alcohol and substance abuse rehabilitation facilities - which probably accounts for Seattle having the highest DASA rate in the county.

Figure 9.04
DSHS Alcohol & Substance Abuse Use Rates



The juvenile rehabilitation rate for King County cities is shown in Figure 9.05. Federal Way, Des Moines and Tukwila are all below the county average while Normandy Park and Burien are above it.

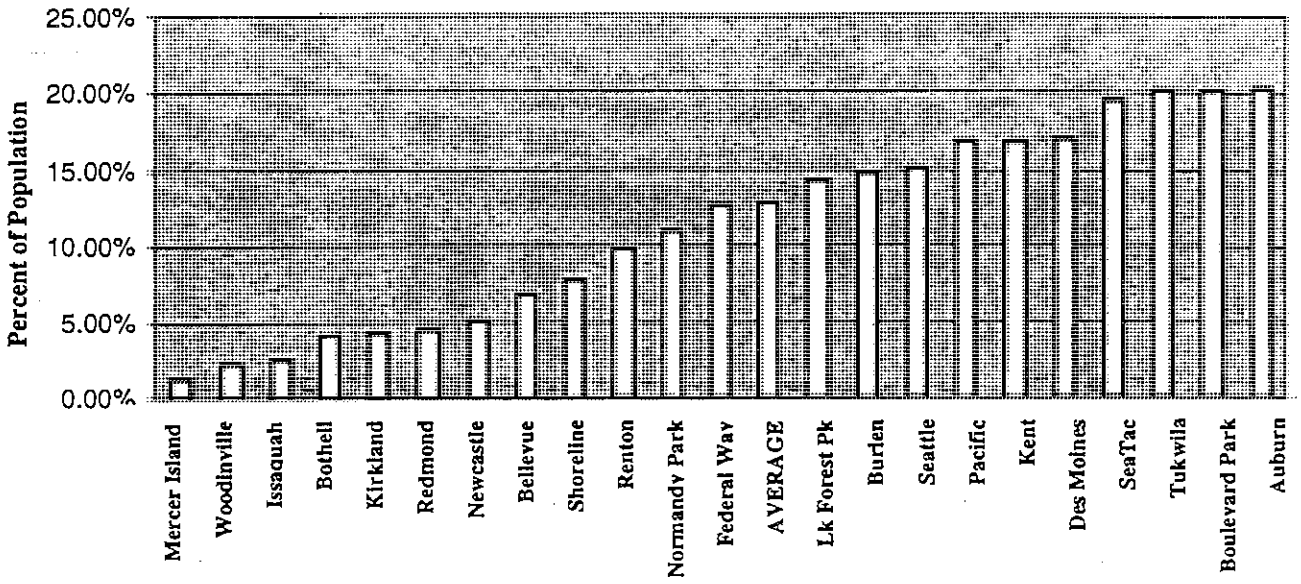
Figure 9.05
DSHS Juvenile Rehabilitation Service Use Rates



The economic security services use rate for county cities is shown in Figure 9.06. Normandy Park and Federal way have rates below the county average, and Burien, Des Moines and Tukwila have rates below the county average.

Overall, Normandy Park and Federal Way have the lowest use rates among the five cities covered by the Sea-Tac International Airport Impact Mitigation Study. This may reflect Federal Way's relatively greater distance from the Airport and both Federal Way's and Normandy Park's locations to the west of the Airport's flight tracks. Since the Third Runway will locate a flight tract to the west, these communities will likely have a greater impact from the Third Runway than they did from Sea-Tac International Airport's first or second runways. The highest social service use rates currently are in Tukwila and Des Moines.

Figure 9.06
DSHS Economic Sercurity Services Use Rates



The Third Runway and related Airport facilities will impact community services and facilities in numerous ways. Environmental and transportation impacts during construction will include the movement of construction vehicles over the road system contained within the District, and will likely affect the movement along, and possibly safety, of public streets and parking places. After construction, environmental impacts will mainly be generated by noise from the growth of aircraft operations from the Third Runway and related Airport facilities will allow Sea-Tac International Airport to exceed its ASV of 380,000 operations after the Year 2000. The impacts of noise on the ability of churches, hospitals, nursing homes, community centers and libraries to function normally is analyzed in the environmental impact sections of this Sea-Tac International Airport Impact Mitigation Study.

As discussed previously, the growth of operations at Sea-Tac International Airport after its 380,000 ASV capacity has been reached around the Year 2000, will mean that the value of residential properties surrounding the Airport will not appreciate as fast as they otherwise would have. The market adjustment to such a relative decline in residential property values will be an alteration in land uses away from owner occupied homes toward renter occupied homes. Since renters have a profile that is younger, more mobile and lower income than owners, communities experiencing the impacts of the Third Runway will have to offer expanded social services if they are to maintain the quality of life achieved in the past.

9.10 - COMMUNITY FACILITIES IMPACTED BY THE THIRD RUNWAY'S FLIGHT TRACK

Employing the DSHS use rates discussed earlier as a guide to the types of impacts the Third Runway and related Airport facilities development will have, the most likely impacts will be generated by the changes in the demographic profile of the population living to the west of the current Sea-Tac International Airport flight tracks. The proportion of renter occupied housing units will likely rise after the Year 2000, and will result in a population needing more child care services, community social services, counseling services and employment assistance services than is either true today or would be true if the Airport were not expanded. Existing facilities at local churches, community centers, schools and libraries will most likely be inadequate to cope with these increased needs and will have to be expanded.

Additional facilities required by Sea-Tac International Airport's Third Runway impacts can be calculated by applying current service use rates per 1,000 of the population, for specific services, to the forecast populations for the impacted cities and subtracting the derived service levels from service requirement levels independently forecast based on the cities' expected demographic shifts. This type of analysis should be reviewed for "reasonableness" by working professionals in both the functional service areas and the agencies/organizations now providing the services in the impacted cities.

The most likely communities to suffer major facility impacts from the Third Runway and related Airport facilities development will be Burien, Des Moines, Normandy Park and Federal Way. Tukwila appears to have suffered the community facility and service need impacts from Sea-Tac International Airport's existing approach/departure flight tracks, but it is to the east of Sea-Tac International Airport and will likely not face the same magnitude of impacts from the approach/departure tracks of the proposed Third Runway. The growth of surface traffic on Pacific Highway South (SH 99) however could easily generate a business environment that gives rise to anti-social and criminal behavior and will require an expansion of Tukwila's public safety personnel and facilities.

No analysis of the community facility requirements was contained in the EIS for the Third Runway and related Airport facilities. The resources and time available under this Sea-Tac International Airport Master Impact Mitigation Study were not sufficient to allow such an analysis to be made using quantifiable research techniques. It is recommended that such a research based analysis be conducted.

Affects of the Third Runway's Flight Track

Community services and facilities in the five impacted communities will be affected by the Third Runway and related Airport facilities in different ways. These include demographic factors, economic factors and psychological factors. None of these factors was considered in the Port of Seattle's Master Plan Update EIS, as a result the information available about these factors only allows for informed speculation and analysis - based on judgments about likely impacts. Additional research should be conducted on each of these factors to determine its statistical significance and magnitude.

- **Demographic Factors** - These factors have already been discussed as an outcome of the land use changes resulting from the growth of operations after the Year 2000 when the Third Runway and related Airport facilities become operational. The increased proportion of rental housing units in the area will produce a resident population that is younger, more mobile and lower income than today's. Given the established correlation between income and the need for community services and facilities, it is likely that future populations in the impacted communities will require higher service levels per capita and more facilities per capita than does the current population.

- **Economic Factors** - The factors adversely impacting the impacted communities will primarily be the reduction in residential property values that will reduce city tax revenues below what they otherwise would have been.

  The decline in relative residential property values between 1995 and the Year 2000 due to the Airport is attributed to a growth of enplanements within the Airport's ASV capacity limit. But the relative property value declines that will reduce revenues after the Year 2000 are attributed to construction of the Third Runway and related Airport facilities.

  In addition to the revenue losses to the impacted communities, local home owners will face a relative decline in the value of their property. At the same time that the cities would be faced with a need to increase expenditures per thousand persons residing in the cities in order to maintain its quality life, it would face growing voter resistance to raising local tax rates. The resulting financial squeeze will be a major economic impact on the cities, and it will rival in importance the impact on home owners of the relative decline in the value of their properties.

  The calculation of quantitatively probable, rather than illustrative, economic impacts on the impacted communities requires a research effort not possible within the resources available under the current Sea-Tac International Airport Impact Mitigation Study. The entire topic of economic impacts of the Third Runway and related Airport facilities on the community facilities and services (a topic which was not addressed at all in the EIS) needs additional research.

- **Psychological Factors** - The factors impacting the cities' needs for community services and facilities as a result of the Third Runway could come from several sources. The interruption of normal family functioning at home by aircraft noise could increase stress on affected families. Also, parents and children unable to engage in normal outdoor activities such as playing games or sports, enjoying park lands, or having outdoor barbecues may suffer the psychological stress associated with the disruption of normal neighborhood-based activities. Additional psychological impacts may be the consequence of living in neighborhoods where household turnover is high and interpersonal relationships are unstable; or from living in households with only one parent and/or which is under severe economic and financial pressure.

The current study was not able to quantitatively investigate psychological factors, but the association of such factors with the types of demographic shifts that will be accentuated by construction of the Third Runway and related Airport facilities is highly probable and warrants further research and analysis.

Need for Additional Community Services/Facilities

The noise impacts on community facilities to the west of Sea-Tac International Airport caused by the increase in approaching/ departing aircraft after the Year 2000, and which are attributable to the Third Runway, related Airport facilities, and expansion of the Airport's ASV capacity, may require remodeling, rebuilding, or other structural alterations. The mitigation of these Third Runway impacts relate to the need to attenuate noise at existing facilities. These requirements are analyzed and their mitigation requirements presented in the environmental part of the Sea-Tac International Airport Impact Mitigation Study.

The impact of the increase in approaching/departing aircraft after the Year 2000 attributable to the Third Runway, related Airport facilities, and expansion of the Airport's ASV capacity on the value of residential properties surrounding the Airport - and as a result, the cities' needs to increase expenditures for community services and facilities - is addressed later in this Section where the mitigation of individual property value losses and community property tax reductions are discussed. Any action that mitigates property losses to individual homeowners or reduces the loss of property tax revenues to communities will also increase the city and School District tax base.

The optimum methods of providing community services as a way to mitigate the demographic shifts that will be caused by the increase in approaching/departing aircraft after the Year 2000 attributable to the Third Runway, related Airport facilities, and expansion of the Airport's ASV capacity will require additional analysis. First, quantitative research needs to be conducted on the affects of the population's shifting demographic profile on the community service needs of affected families. After which, appropriate mitigation policies need to be formulated by community service professionals within each of the impacted cities. Some of these policies will likely include increased community centers, increased child care, expanded levels of police and fire services, and creation of additional community facilities.

Regardless of which or how many of these types mitigation actions will be determined as both needed and appropriate, it is evident that the impacted cities will require additional resources to mitigate the socio-economic impacts of the Third Runway and related Airport facilities.

9.11 - THE IMPACT OF SEA-TAC'S EXPANSION ON PUBLIC SCHOOLS

The Third Runway and related Airport facilities will impact Highline School District's public schools in numerous ways. Environmental and transportation impacts during construction will include the movement of construction vehicles over the road system contained within the District, and will likely affect the movement, scheduling and possibly safety of school busses. After construction, environmental impacts will mainly be generated by noise from the growth of aircraft operations associated with the Third Runway and related Airport facilities which allow Sea-Tac International Airport to exceed its ASV of 380,000 operations.

The impacts of noise on the ability of teachers to teach and students to learn is documented in a variety of ways. A Highline School District study of noise impacts on classroom performance was conducted at Sunset Junior High School, located about six blocks from the end of one of Sea-Tac International Airport's runways, in 1973 (*Aircraft Noise Study: Remedial Construction/Schools*, Highline School District, 1973). Four classrooms were selected, two adjacent rooms on the junior high school's first floor and two on its second floor, where each of the classrooms was estimated to experience five or more minutes of high level aircraft noise per 50-minute classroom period.. One of the first floor rooms and one of the second floor rooms was insulated while the other two rooms were not. Students in all four classrooms were given a math test which evaluated their "concentration and attention-to-task." As shown in Table 9.12, the test scores of students in the insulated classrooms where aircraft noise had been attenuated appear to be significantly higher than the scores of students in the non-insulated classrooms. (The measured statistical significance of the difference in test scores between the insulated and non-insulated classrooms was not reported.)

Table 9.12
Math Test Scores of Students in Insulated and Non-Insulated Classrooms

Classrooms	Sound Proofed Rooms	Non-Sound Proofed Rooms
First-floor classrooms	75.6	64.2
Second-floor classrooms	75.9	57.6

Additional information on the importance of attenuating aircraft noise for learning comes from the experience of classroom teachers. The *Highline News* recently reported a teacher at Cedarhurst Elementary School as follows (Steffens, "No Peace for Students", 23 October 1996):

> *"I just stop class completely when there's a plane going over. Students just stop themselves and look at me and wait until the [aircraft] noise is gone."*

A *Seattle Times* supplement designed to be "a comprehensive guide to public and private high schools in the greater Seattle area" contained the following statement as part of its evaluation of the Highline School District ("Guide to High Schools", 20 November 1996):

> *"A perennial challenge to the District has been its proximity to Seattle-Tacoma International Airport. Some classrooms lie directly beneath the flight path of roaring jets, which disrupts classes, assemblies and outdoor physical education. ... Now, with plans for the Third Runway in the works, school officials worry about the problems worsening."*

As discussed previously, the growth of operations at Sea-Tac International Airport after its 380,000 ASV capacity has been reached around the Year 2000, will mean that the value of residential properties surrounding the Airport will not appreciate as fast as they otherwise would have. The market adjustment to such a relative decline in residential property values will be an alteration in land uses away from owner occupied homes toward renter occupied homes. Since renters have a profile that is younger, more mobile and lower income than owners, a higher proportion of students attending District schools will require enhanced educational services if the District is to maintain the educational outputs (graduation levels, Comprehensive Test of Basic Skills (CTBS) scores, SAT scores, college admission rates) that it achieved in the past.

Whether measured by student test score, educational attainment, or post-school earnings, a wide spread professional consensus exists that the educational attainment of parents, the existence of single parent-headed households, female labor force participation, child poverty, and low household income are important influences on the quality of student outcome (Hanushek, 1996). Consequently, if the District is to maintain its historic quality of educational; outcomes, it will have to compensate for the demographic changes associated with increased renter-occupied housing by providing additional resources per student.

At the same time, the Highline School District will find itself under increased financial pressure as a result of construction of the Third Runway and related Airport facilities. Under Washington State law, State resources are distributed through funding formulas that, when combined with local and Federal resources, equalize educational opportunities throughout the State. Local property tax levies to support schools are determined by local School District needs and the resulting tax rates are submitted for approved to local District voters. The relative reduction in residential property values caused by the Third Runway and related Airport facilities will mean that higher tax rates will be required to generate the same level of resources; and the higher the rates, the more difficulty the District will have in obtaining voter approval.

Thus, at the same time the District's shifting demographic profile will require additional resources to prevent education outcomes from falling, declining relative property values will make it increasingly difficult to obtain voter approval for needed revenues. Both sides of the interaction between District needs for additional resources and voter resistance to approving school levies are traceable to the expansion of aircraft operations at Sea-Tac International Airport made possible by the Third Runway and related Airport facilities, and constitute the socio-economic impacts investigated in this Section.

Impacts on School Age Children Living Under the Third Runway's Approach/Departure Flight Tract

The Third Runway will be to the west of Sea-Tac International Airport's existing 16R/34L runway. The school children most affected consequently will live in areas served by the following elementary schools:

- Beverly Park at Glendale
- Cedarhurst
- Des Moines
- North Hill
- Olympic
- Southern Heights
- Sunnydale

The characteristics of students attending these schools are shown in Table 9.13. All of the Third Runway impacted elementary schools had a higher percentage of non-white students in 1993 than the District average, but they had few other similarities. Three of the seven schools (North Hill, Southern Heights, and Olympic) had a higher percentage of students enrolled in special education classes/programs. Three (Beverly Park, North Hill and Olympic) had a larger percentage enrolled in ESL classes. Four (Beverly Park, Sunnydale, Cedarhurst and Olympic) had a larger percentage than the District average receiving free/reduced cost lunches; but only two (Cedarhurst and Beverly Hills) were below the District average percent of students living in two-parent households.

In terms of their fourth grade Comprehensive Test of Basic Skills (CTBS) test scores compared to the entire District, the six impacted schools were mixed in their relative standings. (North Hill Elementary only has grades K through 3, and consequently does not report CTBS scores.) Beverly Park and Cedarhurst both had scores below the District average in all three test components: reading, math and language. Des Moines had test scores above the District average in all three test components. The remaining three elementary schools were above the District average in at least one of the components and below it in at least another.

In summary, children living in the elementary school service areas to the immediately west of Sea-Tac International Airport's existing boundaries will be the group most directly impacted by the westerly shift of the Airport's approach/departure flight tracks that results from construction of the Third Runway and related Airport facilities. As property values in these areas exhibit a relative decline caused by the growth of Airport operations and an increasing number of single-family residences shift from owner occupancy to renter occupancy, the number of students arriving at school with educational deficits will likely rise. To maintain the quality of educational outcome in the District, classrooms and curriculum will have to be enriched.

Highline High School lies immediately to the west of Sea-Tac International Airport's existing boundaries and it also will be significantly impacted by the Third Runway.

Table 9.13
Student Characteristics at Third Runway Impacted Elementary Schools

		Percent of Total Enrollment				
		Non-White Students	Special Education /Program Students	ESL Students	Free/ Reduced Lunch Students	Living With Two Parents Students
District Average	1990/1991	N/A	N/A	N/A	27.0%	65.0%
	1993	21.3%	8.9%	4,.1%	35.0%	57.0%
Cedarhurst	1990/1991	27.4%	8.0%	9.0%	21.0%	70.0%
	1993	37.3%	7.0%	10.0%	39.0%	56.0%
Beverly Park at Glendale	1990/1991	18.1%	10.0%	0.0%	28.0%	53.0%
	1993	26.4%	8.0%	0.0%	44.0%	51.0%
Des Moines	1990/1991	24.6%	5.0%	8.0%	23.0%	69.0%
	1993	24.5%	2.0%	0.0%	24.0%	58.0%
North Hill	1990/1991	23.4%	9.0%	16.0%	27.0%	70.0%
	1993	23.1%	10.0%	12.0%	34.0%	68.0%
Olympic	1990/1991	31.5%	14.0%	20.0%	40.0%	73.0%
	1993	28.4%	30.0%	16.0%	51.0%	64.0%
Southern Heights (1991)	1990	22.2%	7.0%	0.0%	27.0%	71.0%
	1993	24.4%	13.0%	0.0%	31.0%	63.0%
Sunnydale (1991)	1990	14.7%	3.0%	0.0%	19.0%	54.0%
	1993	33.5%	3.0%	0.0%	43.0%	61.0%

Notes:
1) 1990 data = percent non-white, percent with free/reduced lunch, percent living with two parents.
   1991 data = percent special education classes/programs, percent in ESL classes
2) North Hill has grades K-3 only; Olympic has grades 4-6.

(Source: Highline School District, 1993-94)

Table 9.14
Student Characteristics at Highline High School

Student Characteristic	Highline High School	District Average
Non-white students	25.8%	21.3%
Special education/program students	6.0%	8.9%
ESL students	6.0%	4.1%
Free/reduced lunch students	17.0%	35.0%
Living with two parents students	54.0%	57.0%

(Source: Highline School District, 1993-94)

Importance of Elementary School Impacted Children

The seven elementary schools which will be most impacted by the Third Runway had a combined enrollment in 1993 of 2,807 students, and represented almost one-third (29.5%) of the District's total elementary school enrolled children. Students from Des Moines and Olympic elementary schools matriculate to Pacific Middle School and go on to Rainier High School. Students at Sunnydale and Cedarhurst elementary schools matriculate to Sylvester Middle School and than go on to Highline High School. Students from Beverly Park and Southern Heights elementary schools matriculate to Cascade Middle School and than to Evergreen High School.

Thus, the socio-economic impact of the Third Runway on the demographic profile of enrolled students in elementary schools immediately to the west of the Airport's current boundary will be spread from the seven directly impacted schools to the entire District school system. (Only Chinook Middle School and Tyee High School, both located on the east side of the Airport, will likely not be affected by induced demographic shift attributable to the Third Runway and related Airport facilities.)

Affect of Increased Operations on School Children

The educational performance of children attending school in the Highline School District will be affected by the Third Runway and related Airport facilities in different ways. These include demographic factors, economic factors and psychological factors. None of these factors was considered in the Port of Seattle's Master Plan Update EIS, as a result the information available about these factors only allows for informed speculation and analysis-based judgments about likely impacts. Additional research should be conducted on each of these factors to determine its statistical significance and magnitude.

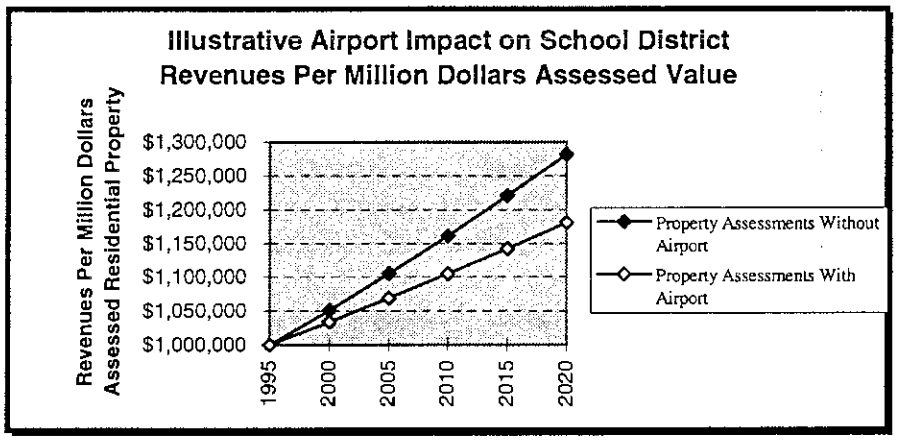
- **Demographic Factors** have already been discussed as an outcome of the land use changes resulting from the growth of operations after the Year 2000 when the Third Runway and related Airport facilities become operational. The increased proportion of rental housing units in the District will produce a resident population that is younger, more mobile and lower income than today's. Given the established correlation between income and educational attainment, it also is likely that the District's future population will have attained lower educational levels than today's population if the Third Runway and related Airport facilities are built.

- **Economic Factors** adversely impacting the Highline School District will primarily be the reduction in residential property values that will require higher special levy rates. For example, the District's most recent special levy rate was 3.015 cents per $1,000 of assessed value. Each million dollars of residential property therefore generates $3,015 of special levy revenue. Assume property values in equivalent areas in King County increase at a rate of 1% per year on average but as a result of increased Sea-Tac International Airport operation property values in the District's residential housing stock increase at only two-thirds of a percent per year. The results of this example are shown in Table 9.15 and Figure 9.07

Table 9.15
Illustrative Impact of Airport on Highline School District Revenues

Year	Property Assessments Without Airport (assumed 1.00% per year property value growth)	Property Assessments With Airport (assumed 0.67% per year property value growth)
1995	$1,000,000	$1,000,000
2000	$1,051,010	$1,033,781
2005	$1,104,622	$1,068,703
2010	$1,160,969	$1,104,804
2015	$1,220,190	$1,142,125
2020	$1,282,432	$1,180,707

Figure 9.07



In the above illustrative example, the decline in residential property values between 1995 and the Year 2000 are attributed to a growth of enplanements within the Airport's existing ASV capacity limit. The relative property value declines after the Year 2000, however, are attributed to construction of the Third Runway and related Airport facilities. In the illustrative example, the School District would have had to increase its levy rate in 2020 from $3.015 to $3.275 per $1,000 of assessed residential property value to equalize the two revenue streams.

Local home owners faced with a relative decline in the value of their property would be asked to approve higher special school levy rates than would otherwise be necessary, and the ability of the District to get voter approval would almost certainly become more difficult. At the same time, the District would be faced with a need to increase expenditures per student in order to maintain the quality of its educational outcomes, it would face growing voter resistance to raising levy rates.

The resulting financial squeeze will be a major economic impact on the School District that results from construction of the Third Runway and related Airport facilities.

The calculation of probable, rather than illustrative, economic impacts on the School District requires a research effort not possible within the resources available under the current Sea-Tac International Airport Impact Mitigation Study. The illustrative differential of one-third of a percent per year in the growth of residential property values with and without the Third Runway appears low on the basis of the property value finding reported previously, and the entire topic of economic impacts of the Third Runway and related Airport facilities on the School District (a topic which was not addressed at all in the EIS) needs additional research.

- **Psychological Factors** impacting the School District's children as a result of the Third Runway could come from several sources. The interruption of classroom teaching by aircraft noise could increase stress on students in affected classrooms. Also, student learning could be impaired in affected west-side elementary schools; and after matriculating to the middle schools in the District, these students may suffer the psychological stress associated with an inability to educationally perform with grade-level peers. Additional psychological impacts may be the consequence of living in neighborhoods where household turnover is high and interpersonal relationships are unstable; or from living in households with only one parent and/or which is under severe economic and financial pressure.

  The current study was not able to investigate the psychological factors, but the association of such factors with the types of demographic shifts that will be accentuated by construction of the Third Runway and related Airport facilities is highly probable and warrants further research and analysis.

The Need for Additional School Services/Facilities

The noise impacts on the seven elementary schools and high school immediately to the west of Sea-Tac International Airport caused by the increase in approaching/departing aircraft after the Year 2000, and which are attributable to the Third Runway, related Airport facilities, and expansion of the Airport's ASV capacity, will require remodeling, rebuilding, or other structural alterations.

The mitigation of the Third Runway impacts are over and above the structural requirements needed to attenuate noise at such schools as Hilltop, Riverton Heights, Midway and Parkside Elementary Schools, Pacific Middle School and Mount Rainier High School that were caused by the second runway and have still not been fully addressed (Highline School District, November, 1992; and Heigh, 24 August 1994). These noise induced structural impacts are analyzed and their mitigation requirements presented in the environmental part of this Sea-Tac International Airport Impact Mitigation Study.

The optimum methods of enriching the classroom learning experience as a way to mitigate the District's demographic shift caused by the increase in approaching/departing aircraft after the Year 2000 attributable to the Third Runway, related Airport facilities, and expansion of the Airport's ASV capacity will require additional analysis. Quantitative research needs to be conducted on the affects of the population's shifting demographic profile on students' classroom performance. After which, appropriate mitigation policies need to be formulated by educational professionals within the District. Some of these policies will likely include reduced student/teacher ratios, increased teacher support staff in classrooms, creation of enriched curricula, and use of additional teaching materials. Regardless of which or how many of these types of mitigated actions will be determined to be appropriate for maintaining the Highline School District's traditional quality of education outcomes, it is evident that the District will require additional resources to mitigate the socio-economic impacts of the Third Runway and related Airport facilities.

9.12 - MITIGATION OF SEA-TAC'S ADVERSE IMPACTS

The expansion of Sea-Tac International Airport will produce adverse socio-economic impacts on both households and communities in its immediate environment. Section 9.12 discusses appropriate mitigation measures for both types of impacts in three categories of mitigation: mitigation based on tax base change, mitigation based on service level changes, and mitigation based on other changes. Mitigation measures are divided into the following types:

- **Tax Base Changes**
  - Depressed Property Values
  - Reduced School Revenues
  - Reduced Local Government Revenues
  - Land Use Changes

- **Service Level Changes**
  - Public Safety
  - Community Cultural Services
  - Community Social Services
  - Educational Services
  - Health Services

- **Other Socio-Economic Impacts**
  - Environmental Justice
  - Quality of Life
  - Economic Development

9.13 - TAX BASE CHANGES

Depressed Property Values

The primary impact on households will be the decline in the relative value of residential property caused by Sea-Tac International Airport's expanded operations after the Year 2000 - as will result from construction of the Third Runway and related Airport facilities. Table 9.16 reports the average relative decline in housing values for each of the five impacted cities for the Years 2000 to 2020. (the data in Table 9.16 are derived from Table 9.03.)

Between the Years 2000 and 2020, the average residential housing unit (land plus structure) in Burien is expected to experience a relative decline of $26,356 (expressed in constant value 1995 dollars). For the City of Des Moines the comparable number is $27,609; for Federal Way it is $28,891; for Normandy Park it is $35,221; and for Tukwila it is $24,844.

To make residents of the five impacted cities whole, each household would receive the equivalent of a 20-year annuity where the sum of the annuity's payments equals the relative loss of the property value. In Burien, for example, each affected household would receive an annual payment such that the sum of the payments from the Year 2000 to 2020 discounted for real time preference would equal $26,356.

Having the Port of Seattle contribute an amount equal to the above described annual annuity payment toward the payment of a householder's annual property taxes would have the same effect as giving each householder an annuity. It would have the additional benefit of attaching the mitigating action to the property that's being impacted rather than to the householders residing on the property. Further, market forces should increase the value of the property by the discounted present value of the annuity's payment stream (the Port's contribution to the property's tax obligations), and this increase in property values will increase revenues to the five impacted cities - thus mitigating the cities' revenue shortfalls at the same time.

As mitigation for the loss of relative residential property values by homeowners, it is recommended that the Port of Seattle make a partial payment of property taxes for homeowners in the five impacted cities, the amount of the partial payment equal to an annuity the present value of whose payments equals the property's loss of relative value caused by expansion of the Airport.

Table 9.16
Average Housing Unit's Relative Decline in Value Caused by Sea-Tac's Expansion

Year	Burien	Des Moines	Federal Way	Normandy Park	Tukwila
2000	---	---	---	---	---
2001	-$1,318	-$1,380	-$1,450	-$1,761	-$1,242
2002	-$2,636	-$2,761	-$2,899	-$3,522	-$2,484
2003	-$3,954	-$4,141	-$4,349	-$5,283	-$3,727
2004	-$5,271	-$5,522	-$5,798	-$7,044	-$4,969
2005	-$6,589	-$6,902	-$7,248	-$8,805	-$6,211
2006	-$7,907	-$8,283	-$8,697	-$10,566	-$7,453
2007	-$9,225	-$9,663	-$10,147	-$12,327	-$8,696
2008	-$10,543	-$11,044	-$11,596	-$14,088	-$9,938
2009	-$11,861	-$12,424	-$13,046	-$15,849	-$11,180
2010	-$13,179	-$13,804	-$14,496	-$17,610	-$12,422
2011	-$14,497	-$15,185	-$15,945	-$19,371	-$13,664
2012	-$15,815	-$16,565	-$17,395	-$21,132	-$14,907
2013	-$17,133	-$17,946	-$18,844	-$22,893	-$16,149
2014	-$18,450	-$19,326	-$20,294	-$24,654	-$17,391
2015	-$19,768	-$20,707	-$21,743	-$26,416	-$18,633
2016	-$21,086	-$22,087	-$23,193	-$28,177	-$19,875
2017	-$22,404	-$23,468	-$24,642	-$29,938	-$21,118
2018	-$23,722	-$24,848	-$26,092	-$31,699	-$22,360
2019	-$25,040	-$26,228	-$27,542	-$33,460	-$23,602
2020	-$26,356	-$27,609	-$28,891	-$35,221	-$24,844
Average	**-$13,179**	**-$13,804**	**-$14,496**	**-$17,610**	**-$12,422**

The approximate amount of such payments is show in Table 9.17, along with the estimated average annual cost to the Port. The numbers in Table 9.17 are a mitigation guideline and will have to be modified to account for differences between the average value of all housing units in a city and the actual value of specific properties and adjustment for inflation during the 20-year period between the Years 2000 and 2020. The table uses a real interest rate of 4% for its calculations. During 1995, the interest rate on a 30-year government bond was around 6.5% and the rate of inflation was around 2.5%, yielding a real rate of interest for long term assets of around 4%.

Table 9.17
Estimated Cost of Mitigating Residential Housing Unit Property Losses

Community	Contribution by Port to Average Residential Property's Tax Obligation	Average Number of Impacted Single-Family Housing Units	Total Cost to Port of Seattle
Burien	$885	17,890 DU	$15,832,650
Des Moines	$927	6,197 DU	$5,744,619
Federal Way	$973	12,392 DU	$12,057,416
Normandy Park	$1,182	2,577 DU	$3,046,014
Tukwila	$834	4,866 DU	$4,058,244
Total			**$40,738,943**

Reduced School Revenues

Reduced school revenues will result from the relative decline in residential property values caused by expansion of Sea-Tac International Airport after the Year 2000. If the Port of Seattle undertakes a program of making partial property tax payment for residential properties in the affected cities, market forces will bid up the price of these properties and off-set the relative declines that would otherwise occur. Consequently, there would be no reduction in school revenues (increases in levy rates) and no additional mitigation would be required.

If the Port of Seattle does not mitigate the relative decline in residential property values caused by the Third Runway and related Airport facilities, the Highline School District will experience revenue shortfalls, compared to what would have occurred had the Airport not expanded. The estimation of these revenue shortfalls is complex and needs to account for both the business personal property tax receipts generated by the Airport to the School District and Washington State's educational funding formulas. It was beyond the budget and scope of this study, but the full effects should be calculated.

It is recommended that a detailed analysis of the likely shortfall in Highline School District's property tax base that will result from construction of the *Third Runway and related Airport facilities be conducted.*

Reduced Local Government Revenues

Reduced local government revenues will result from the relative decline in residential property values caused by expansion of Sea-Tac International Airport after the Year 2000. If the Port of Seattle undertakes a program of making partial property tax payment for residential properties in the affected cities, market forces will bid up the price of these properties and off-set the relative declines that would otherwise occur. Consequently, there would be no reduction in local government revenues and no additional mitigation would be required.

If the Port of Seattle does not mitigate the relative decline in residential property values caused by the Third Runway and related Airport facilities, the city governments of Burien, Des Moines, Federal Way, Normandy Park and Tukwila will experience revenue shortfalls, compared to what would have occurred had the Airport not expanded. The cumulative revenue losses to all five impacted cities from all Third Runway related impacts will be $38.8 million (in constant value 1995 dollars), ranging from an annual revenue loss of $1.7 million during the first year after the Third Runway goes into operation to an annual revenue loss of $2.2 million in the Year 2020.

If the Port of Seattle does not take action to mitigate the decline in relative residential property values by making partial property tax payments to homeowners, it is recommended that the Port of Seattle make annual off-setting payments to each of the five impacted cities to compensate them for the relative declines in residential property values caused by construction of the Third Runway and related Airport facilities.

The magnitude of the off-setting payments should be determined by each city's revenue losses. Table 9.18 presents estimates of these revenue losses.

Table 9.18
Estimated Revenue Loss Off-Setting Mitigation Payments

Community	Total Revenue Losses from Relative Declines in Single-Family Property Values 2000-2020	Average Yearly Decline in Single-Family Property Values 2000-2020	Annual Tax Revenue Loss Off-Setting Mitigation Payments
Burien	-$14,191,858	-$709,592	$709,592
Des Moines	-$6,389,351	-$319,468	$319,468
Federal Way	-$11,611,022	-$580,551	$580,551
Normandy Park	-$2,813,667	-$140,683	$140,683
Tukwila	-$3,747,651	-$187,383	$187,383

Land Use Changes

Land use changes in the form of a shift from owner occupied to renter occupied residential properties will result from the relative decline in residential property values caused by expansion of Sea-Tac International Airport after the Year 2000. If the Port of Seattle undertakes a program of making partial property tax payments for residential properties in the affected cities, market forces will bid up the price of these properties and off-set the relative declines that would otherwise occur. Consequently, there would be no market pressure for shifts in land use patterns and no additional mitigation would be required.

If the Port of Seattle does not mitigate the relative decline in residential property values caused by the Third Runway and related Airport facilities, there will be a need to mitigate the affects of having more transient residents living in the five impacted cities.

It is recommended a revolving "Home Ownership Loan Fund" be established to facilitate the movement of persons living in Burien, Des Moines, Federal Way, Normandy Park and Tukwila from renter to owner housing tenure status.

Additional analysis will be required to determine the size of the loan fund, but a rough estimate of assistance provided to approximately 500 households a year in achieving home ownership status would indicate the size of the fund should be in the range of $15 million to $25 million. It is assumed that the home ownership program would operate through loan guarantees and the majority of the funding would be provided through private financial institutions.

9.14 - SERVICE LEVEL CHANGES

Expansion of Sea-Tac International Airport through construction of the Third Runway and related Airport facilities will increase the proportion of renters among residents of the five impacted cities. As a result, the cities will experience a shift in population toward younger, lower income and more mobile households. This shift will require an increase in community services if the cities are to retain the quality of life they had in the past.

Public Safety

Public safety requirements will increase for all five of the impacted cities. The Cities of Burien, Des Moines and Tukwila will have the greatest requirements for additional neighborhood patrolling by uniformed police officers. The growth of operations at Sea-Tac International Airport after the Year 2000 will particularly impact the City of Tukwila where Airport-induced neighborhood decline is already advanced on Pacific Highway South and will continue to worsen.

It is recommended that as part of the mitigation of the Third Runway and related Airport facilities at Sea-Tac International Airport there be a program whereby the Port of Seattle reimburses the Cities of Burien, Des Moines and Tukwila for the additional public safety requirements they will experience.

Community Cultural Services

Given the demographic shift expected to occur in the five impacted cities as a result of construction of the Third Runway and related Airport facilities, the continuance of their quality of life will require an enrichment of the cultural resources available to their residents. In particular, it will be important to expand the availability of central meeting places such as parks, libraries and community centers where new residents can meet their neighbors and become integrated into their communities. The greatest needs will occur in the Cities of Burien, Des Moines and Tukwila, although significant, but lesser, pressure for additional community cultural resources will be experienced in the cities of Federal Way and Normandy Park.

It is recommended that each of the five impacted cities draw-up a cultural resources enhancement plan specifically directed toward meeting the quality of life challenge that the Third Runway and related Airport facilities, will impose, and that the actions identified as needed in each city's cultural resources enhancement plan be funded as part of the mitigation of the construction of the Third Runway and related Airport improvements.

Community Social Services

Community social services such as day care and after school care, elderly centers, family counseling services, work training and job search counseling will all be required in the five impacted cities that were the focus of the Sea-Tac International Airport Mitigation Impact Study. Over and above the needs for such services that a growing population will require, the demographic shift caused by the increase in Sea-Tac International Airport operations that will be made possible by expansion of the Third Runway and related Airport facilities, will cause an expanded growth in demand for social services. If the impacted cities are only able to provide increased social services in proportion to their population growth, and are not able to provide for the additional social services made necessary by construction of the Third Runway and related Airport facilities, their quality of life will be progressively diminished after the Year 2000.

It is recommended that the five impacted communities develop a southwest King County integrated community social service resource and delivery plan and that the plan, once developed, be funded as part of the mitigation of the Third Runway's impacts.

Educational Services

There will be a need to enrich classroom learning experiences in order to mitigate demographic shift among the Highline School District students that will be caused by the Third Runway and related Airport facilities. To determine the best mitigation measures, quantitative research needs to be conducted on the affects of shifting demographic profiles on student classroom performance. After which, appropriate mitigation policies need to be formulated by educational professionals within the District. Some of these policies will likely include reduced student/teacher ratios, increased teacher support staff in classrooms, creation of enriched curricula, and use of additional teaching materials. Regardless of which or how many of these types of mitigation actions will be determined as appropriate for the task of maintaining the Highline School District's traditional quality of education outcomes, it is evident that the District will require additional resources to mitigate the socio-economic impacts of the Third Runway and related Airport facilities.

It is recommended that additional research be undertaken to develop quantitative estimates of the relationship between demographic shifts in the Highline School District's student population, levels of student performance and appropriate mitigation measures to maintain the District's traditional quality of education outcomes; and that such measures be funded as part of the mitigation of the Third Runway's impacts.

Health Services

High levels of concern have been expressed by citizens and community leaders from the five impacted cities about the deleterious affects the Airport now has on the health of families living in its immediate environment. If such concerns are demonstrated as warranted, they would apply forcefully to the expansion of Airport operations that will occur as a result of building the Third Runway and related Airport facilities. A public health evaluation and assessment of the Airport was outside the scope and budget of this study.

It is recommended that the School of Public Health at the University be funded to conduct an Airport health impact assessment, and that if the assessment finds a positive correlation between adverse health impacts and levels of Airport operation, appropriate measures to mitigate these affects be funded.

9.15 - OTHER SOCIO-ECONOMIC IMPACTS

Environmental Justice

Parts of the City of Burien that are the home of an ethnically diverse population will be impacted by Sea-Tac International Airport's expansion that construction of the Third Runway and related facilities will allow.

It is recommended that a monitoring system by established and operated in the area to the north of the Airport which will be under the approach/departure flight track for the Third Runway to insure that the intent of federal Executive Order 12898, "Environmental Justice" are met.

Quality of Life

Most of the issues surrounding the socio-economic impact of the Third Runway and related Airport facilities, on neighboring communities involves their quality of life and the manner in which expansion of operations at the Airport will cause it to be degraded. The quality of life issue is central to understanding the socio-economic impacts of the Third Runway and developing effective mitigation strategies. This issue needs to be approached in a straight forward manner, and the development of prototype quality of life indicator systems, both nationally and in the Puget Sound Region, should make this possible.

It is recommended that a quality of life indicator model be created for the five impacted cities and for areas in Northwest King County which are appropriate as a comparison area; the indicator model be estimated for data at least as far back as 1960 for both the impacted and comparison cities; that it be used to identify changes in the impacted cities' relative quality of life over time, the major quality of life indicators which contributed to the decline; and the quality of life indicator model become the basis for identifying needed socio-economic mitigation measures for the Third Runway and related Airport facilities.

Economic Development

Many of the adverse impacts of the Third Runway and related Airport facilities have to do with the direct, indirect or induced relative declines in property values that occur when Airport operations increase. One strategy for mitigating these property value impacts is to direct to the maximum extent, feasible airport economic functions into the five impacted cities. For example, if Sea-Tac International Airport's proposed new hotel were located in Burien or Des Moines instead of on Airport lands there would be a positive (mitigating) result. Equally, if the Airport were to construct a haul road for all air cargo movements which exited on the west side of the Airport, it is highly likely that new warehousing and distribution facilities would spring-up; and the increased value of economic activity thus resulting would mitigate the Third Runway's otherwise adverse impacts. In many ways, a mitigation strategy which depends, at least in part, on economic development enhancing actions is preferable to alternative types of mitigation since it uses market forces rather than government spending or regulation as its implementing force.

It is recommended that an economic and engineering assessment of Airport operations be conducted to determine Airport functions which would have positive economic development benefits and could be shifted to the five impacted cities.

SECTION 10
SUMMARY OF FINDINGS

SECTION 10
SUMMARY OF FINDINGS

10.01 - INTRODUCTION

The consultant team was charged with the task of reviewing and evaluating the impacts of the proposed Third Runway project at Sea-Tac International Airport. Given the study's schedule and budget, the consultant team was directed to utilize existing data in reviewing the proposed project. In accomplishing this task, the consultant team relied principally on data, studies, reports, and documents supplied by:

- The Port of Seattle.
- The Cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila.
- The Puget Sound Regional Council.
- King County.
- The City of Seattle.
- Various regional departments and agencies.
- Various departments and agencies of the State of Washington.
- Various departments and agencies of the Federal government.

A technical reference bibliography appears in Appendix B of this report.

During 1996, various meetings were conducted in the study area and in the City of Olympia with representatives of the Port of Seattle, the five impacted communities, the general public, and various local, regional, State and Federal agencies. A list of project contacts made during this study appears in Appendix C of this report.

10.02 - EIS REVIEW

Sections 2 through 4 of this report presented an analysis of the Port of Seattle's Environmental Impact Statement and evaluated its findings with regards to potential general environmental impacts, transportation impacts and socio-economic impacts.

Environmental

Generally, the EIS did a good job of presenting potential environmental impacts. However, certain areas of improvement were noted, including but not limited to:

- Re-running the new Integrated Noise Model using the newest version and running the model to calculate the 55 LDN contour line.

- Addressing the issue of single-event noise levels and their associated impacts on surrounding residential and non-residential activity.

- Re-running the air quality model using re-sampled data which occurs within the study area rather than 5 miles away from the Airport.

- Further developing the visual impact analysis utilizing color photographs and additional viewing locations.

- Performing additional analyses on overflight and vibration impacts.

- Expanding the analysis of aquifer impacts to study all of the Highline Aquifer within the study area, as well as other aquifers.

These areas of concern - and others as identified in Section 2 - should be fully addressed prior to construction of the Third Runway.

Transportation

As above, the EIS did a good job of presenting potential transportation impacts. However, certain areas of improvement were noted, including but not limited to:

- Expanding the analysis area of transportation impacts to include the surrounding impacted communities, rather than just looking at the "driveways" to the Airport property.

- Expanding the analysis of the haul alternatives and preparing detailed operational procedures for the proposed alternative.

- Improving the analysis of the impacts to the local street system and the State roadway network.

- Improving the analysis of projected load impacts to bridges on the State network.

- Addressing the impacts of construction and post-construction traffic on local traffic diversion, school/transit routes, and emergency vehicle access.

These areas of concern - and others as identified in Section 3 - should be fully addressed prior to construction of the Third Runway.

Socio-Economic

The Port of Seattle's EIS does not present an adequate discussion, analysis and mitigation of the socio-economic impacts associated with the proposed project. The consultant team did not question the overall benefit of an expanded Sea-Tac International Airport. However, as the analysis in Sections 4 and 9 shows, while the Airport's benefits are distributed regionally and Statewide, the costs and impacts are disproportionally distributed among the five impacted communities.

The EIS does not address the socio-economic impacts of the proposed project on local social and community services, such as public safety and education. It also does not address the depression of local property values (with respect to other similar King County areas that are not impacted by an airport).

The socio-economic analyses recommended in Sections 4 and 9 should be completed by the Port of Seattle prior to construction of the Third Runway.

10.03 - MITIGATION CASE STUDIES

Sections 5 and 6 of this report presented a summary of various other mitigation experiences at other US airports (Section 5) and other major projects in Washington State (Section 6).

Other airport projects - notably the addition of two new runways at Dallas/Fort Worth International Airport - proposed a more comprehensive mitigation approach which addressed the effects on whole neighborhoods, rather than just individual structures. The Washington State examples clearly demonstrated the precedent in Washington to extend mitigation programs beyond "traditional" physical remediation to also include social and economic mitigation.

It also does not appear that the proposed project follows the requirements of the State of Washington's *Growth Management Act* (Washington Administrative Code 197-11-060, 197-11-442, and 197-11-443). The GMA fundamentally changed the process of planning in the State. It affects all local jurisdictions, but most significantly, those within the 29 counties planning under the Act. The GMA establishes 13 goals, requires the development of countywide planning policies (including mufti-county countywide planning policies for the central Puget Sound region), local general purpose governmental comprehensive plans with mandatory elements and implementing development regulations. these plans and their implementing agencies must be internally consistent. They must also be consistent with adjacent jurisdictions.

A specific requirement of plans is that they contain a capital facilities plan element identifying those facilities necessary to support the plan and including how these facilities will be financed. The requirements for transportation components are more detailed including the requirement for regional and State consistency. State agencies are required to act consistently with these plans and regulations. Special districts' plans and facilities must also be in conformity.

Each local government in the study area has adjusted their initial comprehensive plan with the exception of Burien, which is in the process of developing its initial comprehensive plan under GMA. Incorporated in 1992, Burien has adopted policies under GMA to guide planning and development in the interim period. Each jurisdiction has developed their plan to accommodate projected future growth as determined by the Washington State Office of Financial Management and distributed by the King County Countywide Planning Policies. What, if any, impacts the implementation of the updated Airport Master Plan Update will have on these jurisdictions was not analyzed nor incorporated in the development of these plans.

GMA requires that there be consistency in three important ways:

- Local jurisdictions' comprehensive plans must be internally and externally (with adjacent communities) consistent. How these jurisdictions change their plan to accommodate the anticipated impacts of the Third Runway will open a window for a State challenge by citizens, other local governments, or the State.

- The State transportation plan, the regional transportation plan and local jurisdictions' transportation elements within their comprehensive plans are required to be consistent. In an interesting balancing of interests, no single plan dominates nor can any one dictate what must be done in another plan. As currently practiced, all parties must negotiate until there is "consistency".

- State agencies are required to comply with adopted local comprehensive plans and implementing development regulations including the expenditure of operational, grant, and capital facility funding.

The GMA requires local jurisdictions to specifically identify in their comprehensive plans those capital facilities necessary to support future development. at specific levels of service. The comprehensive plan must specifically identify how these facilities will be financed. If financing is not feasible, the plans must be revised until feasibility is achieved.

The GMA places the primary responsibility for planning for future growth in the hands of local elected officials. The overall result should be coordinated, consistent local plans which are financially feasible and work together within the region to support a broad vision for the future. State and local agencies are bound to support these plans in their actions.

Failure to meet responsibilities leaves jurisdictions vulnerable to challenges through the Growth Management Hearings Board or superior court. In the former, jurisdictions found out of compliance are potentially subject to loss of revenues, loss of grant funds, and loss of revenue authority. It appears that the proposed Third Runway project does not comply with the requirements of the State's Growth Management Act.

10.04 - RECOMMENDED ENVIRONMENTAL MITIGATION

Section 7 of this report presented the recommend environmental mitigation program to address the projected impacts of the proposed Third Runway.

In summary, prior to construction of the Third Runway, the following mitigation measures should be accomplished:

- Establish a working group/oversight commission to participate with the FAA and other parties in overseeing the application of mitigation measures and programs.

- Run the latest version of the INM to further refine the projected LDN and SEL noise contours and include the 55 LDN contour.

- Based on the INM results, relocate all eligible residents, businesses, schools, churches, and other uses incompatible with extended periods of high-volume aircraft noise. Relocation should be based on neighborhood boundaries.

- Based on the INM results, insulate all eligible residential, business, school, church, and other structures generally incompatible with extended periods of high-volume aircraft noise. Owners of these structures also should be paid for an avigation easement which stays with the property in perpetuity. Insulation and easements should be offered based on neighborhood boundaries.

- Establish additional threshold data which provides detailed information about the threshold above (TA) noise metric with respect to sensitive noise receptors such as schools, hospitals, etc. This information should be developed by the Port of Seattle as part of the re-evaluation of the noise data using the INM, Version 5.1 (or most recent available version).

- Establish a permanent noise monitoring program which locates monitoring stations along predicted noise contours. Additional stations beyond the 25 proposed by the Port of Seattle may be required.

- Utilize permanent and/or portable "hush houses" in conjunction with engine maintenance activities, in particular run-ups.

- Continue or establish noise programs such as a Noise Budget, a Nighttime Limitations Program, a Ground Noise Control Program, Overflight Noise Abatement Procedures, Flight Path Monitoring, and a 24-Hour Noise Information Line.

- Establish a noise mediation agreement which specifies how the Port will deal with exceedances and violations of noise programs.

- Amend the Four-Post Plan to minimize overflights over population areas.

- Require a Dust Control Plan as part of the contractor's permit to construction fugitive dust impacts.

After the Third Runway is operational, the following mitigation measures should be accomplished:

- Utilize the Third Runway for arrivals only during inclement weather in order to help control noise levels associated with departures. There should be no arrivals on the Third Runway, except for emergencies, between 9:00 PM and 7:00 AM.

- Utilize new technologies such as Microwave Landing System (MLS) and Global Positioning Satellite System (GPS) as part of potentially reducing noise impacts to areas around the Airport.

- Conduct a study to determine if it is possible to reduce aircraft emissions by improving Airport operations associated with queuing and taxiing.

The complete listing of mitigation recommendations may be found in Section 7. Environmental mitigation associated with the impacts as delineated in Section 7 as shown in Table 10.01.

Table 10.01
Environmental Mitigation

Environmental Mitigation	Community					Total
	Burien	Des Moines	Federal Way	Normandy Park	Tukwila	
Noise and vibration	$636.6 M	$1,481.4 M	$148.1 M	$55.8 M	$113.5 M	$2,435.4 M
Air quality	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Surface water	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Ground water	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Wetlands	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Floodplains	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Aesthetic/visual	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Other	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Total	**$636.6 M plus TBD**	**$1,481.4 M plus TBD**	**$148.1 M plus TBD**	**$55.8 M plus TBD**	**$113.5 M plus TBD**	**$2,435.4 M plus TBD**

As can be easily seen, most of the environmental mitigation costs are not yet identified. This is due to the amount of additional study still required. Of the approximately $2.4 billion in identified mitigation costs, approximately $2.0 billion (84%) is associated with potential relocation and redevelopment of neighborhoods within Burien and Des Moines. Should this option not be selected, mitigation costs should be significantly lower. All TBD (to be determined) costs should be reconciled prior to construction of the Third Runway.

10.05 - RECOMMENDED TRANSPORTATION MITIGATION

Section 8 of this report presented the recommended transportation mitigation program to address the projected impacts of the proposed Third Runway.

In summary, prior to construction of the Third Runway, the following mitigation measures should be accomplished:

- Perform an Origin-Destination Survey and develop a Cost Allocation Model to determine the amount of impacts attributable to Airport traffic.
- Perform an Areawide Traffic Study to determine region-wide traffic demands on the network surrounding the Airport.
- Develop an Incident Management Plan to respond to emergencies in the study area during and after construction.
- Implement Surface Transportation Noise Mitigation measures to minimize the impacts of freeway noise in the study area.
- Establish baseline conditions for State roads and bridges to measure further deterioration attributable to increased heavy haul truck traffic.
- Select the method of transporting fill material to the construction site (either truck hauling or barge/conveyor/rail) and develop a separate environmental assessment and an emergency contingency plan for the selected transport method.
- Mitigate all identified neighborhoods for corridor congestion impacts.
- Further study the projected traffic impacts on transit and Highline School District bus routes and develop mitigation measures including re-routing/rescheduling, relocation of bus-stops, and/or additional buses and drivers.
- Further study the projected traffic impacts on police and emergency vehicle response time in the five impacted communities and develop mitigation measures including additional equipment, additional personnel, and/or new station locations.
- Conduct monitoring of the serviceability index of local and State roads, and the condition/load rating of State-jurisdiction bridges and rehabilitate or reconstruct these facilities as needed.

During and after construction of the Third Runway, the following mitigation measures should be accomplished:

- Mitigate all identified neighborhoods for corridor congestion impacts.

- Each City should develop a transportation management plan as part of its ongoing transportation planning functions.

Table 10.02
Transportation Mitigation

Transportation Mitigation	Community					Total
	Burien	Des Moines	Federal Way	Normandy Park	Tukwila	
Congestion	$26.4 M	$16.9 M	$20.8 M	$9.8 M	$43.7 M	$117.6 M
Physical damage	$49.8	$22.7 M	$25.9 M	$17.7 M	$70.4 M	$186.5 M
Construction	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD	$ TBD
Post-construction	$40.6 M	$33.2 M	$0.0 M	$23.4 M	$77.6 M	$174.8 M
Total	**$116.8 M plus TBD**	**$72.8 M plus TBD**	**$46.7 M plus TBD**	**$50.9 M plus TBD**	**$191.7 M plus TBD**	**$478.9 M plus TBD**

(Source: Section 8, SeaTac Impact Mitigation Study)

Of the nearly $500 million in transportation mitigation identified, approximately 39% is to address the effects of physical damage to the roadway network. About 40% of the total transportation mitigation costs occur within the City of Tukwila, principally because of the high number of State-jurisdiction roads and bridges. Burien and Des Moines account for another 40% of the total costs due to their close proximity to the Airport and project site.

It is significant that most of the costs associated with construction impacts are not yet known and **should be fully identified prior to construction**. Costs for transportation mitigation have not been assigned to any particular funding agency, but it is likely that the Cities, the State of Washington, the Federal Highway Administration/US DOT, and the Port of Seattle will all participate in project funding at various levels.

10.06 - RECOMMENDED SOCIO-ECONOMIC MITIGATION

Section 9 of this report presented the recommended socio-economic mitigation program to address the projected impacts of the proposed Third Runway.

In summary, prior to construction of the Third Runway, the following mitigation measures should be accomplished:

- As mitigation for the loss of relative residential property values by homeowners, it is recommended that the Port of Seattle make a partial payment of property taxes for homeowners in the five impacted cities, the amount of the partial payment equal to an annuity the present value of whose payments equals the property's loss of relative value caused by expansion of the Airport.

- A detailed analysis should be prepared of the likely shortfall in Highline School District's property tax base that will result from construction of the Third Runway and related Airport facilities.

- The Port of Seattle should make annual off-setting payments to each of the five impacted cities to compensate them for the for the additional public safety requirements they will experience as a result of the Third Runway and related Airport facilities.

- The Port of Seattle should make off-setting payments to each of the five impacted cities to compensate them for the relative declines in residential property values caused by construction of the Third Runway and related Airport facilities.

- A revolving "Home Ownership Loan Fund" should be established to facilitate the movement of persons living in Burien, Des Moines, Federal Way, Normandy Park and Tukwila from renter to owner housing tenure status.

- Each of the five impacted cities should develop a cultural resources enhancement plan specifically directed toward meeting the quality of life challenge that the Third Runway and related Airport facilities will impose, and that the actions identified as needed in each city's cultural resources enhancement plan be funded as part of the mitigation of the construction of the Third Runway and related facilities.

- Each of the five impacted communities should develop a Southwest King County integrated community social service resource and delivery plan and that the plan, once developed, be funded as part of the mitigation of the Third Runway's impacts.

- Additional research should be undertaken to develop quantitative estimates of the relationship between demographic shifts in the Highline School District's student population, levels of student performance and appropriate mitigation measures to maintain the District's traditional quality of education outcomes; and that such measures be funded as part of the mitigation of the Third Runway's impacts.

- The School of Public Health at the University of Washington should be funded to conduct an Airport Health Impact Assessment, and that if the assessment finds a positive correlation between adverse health impacts and levels of Airport operation, appropriate measures to mitigate these affects should also be funded.

- A monitoring system should be established and operated in the area to the north of the Airport which will be under the approach/departure flight track for the Third Runway to insure that the intent of Federal Executive Order 12898, "Environmental Justice" is met.

- A Quality Of Life Indicator Model should be created for the five impacted cities and for areas in Northwest King County which are appropriate as a comparison area, to be used to identify changes in the impacted cities' relative quality of life over time and become the basis for identifying needed socio-economic mitigation measures for the Third Runway and related Airport facilities.

- An economic and engineering assessment of Airport operations should be conducted to determine Airport functions which would have positive economic development benefits and could be shifted to the five impacted cities.

Table 10.03
Socio-Economic Mitigation - 2000 to 2020

Socio-Economic Mitigation	Community					Total
	Burien	Des Moines	Federal Way	Normandy Park	Tukwila	
Total	$14.2 M	$6.4 M	$11.6 M	$2.8 M	$3.7 M	$38.7 M

10.07 - SUMMARY

A total of $2.95 billion in mitigation costs have been identified for the five impacted communities in the areas of environmental, transportation, and socio-economic impacts (see Table 10.04).

Table 10.04
Total Identified Mitigation Costs for the Five Impacted Communities

Community	Mitigation Costs			
	Environ-mental	Transpor-tation	Socio-Economic	Total
Burien	$636.6 M	$116.8 M	$14.2 M	**$767.6 M**
Des Moines	$1,481.4 M	$72.8 M	$6.4 M	**$1,560.6 M**
Federal Way	$148.1 M	$46.7 M	$11.6 M	**$206.4 M**
Normandy Park	$55.8 M	$50.9 M	$2.8 M	**$109.5 M**
Tukwila	$113.5	$191.7 M	$3.7 M	**$308.9 M**
Total	**$2,435.4 M**	**$478.9 M**	**$38.7 M**	**$2,953.0 M**

It is not surprising that of the total **known** and **calculated** amount of $2.95 billion, approximately 79% ($2.3 billion) covers mitigation within the Cities of Burien and Des Moines. These are the two cities within the study area that immediately abut the project site. Most of the mitigation costs in Burien and Des Moines ($2.1 billion or approximately 72% of the total) account for the acquisition/relocation/redevelopment alternative described earlier.

As mentioned in this study, it is not recommended that these areas be totally acquired and redeveloped. This study has calculated a value of these areas at approximately $2.1 billion. Their future development should be further studied by Burien and Des Moines as part of each city's Comprehensive Plan and should be in conformance with the State's GMA requirements.

Tukwila's mitigation costs are third in line, primarily because of the extensive State roadway network within the City.

Federal Way's mitigation costs are primarily associated with sound in insulation and avigation easements for residences affected by SEL and overflight noise. Modification of the Four-Post Plan and the projected Third Runway flight tracks may also mitigate these areas for significantly lower costs. However, it has not yet been determined if there are available flight tracks which would not affect any resident in Southwest King County.

As the smallest community in size and population, Normandy Park's mitigation costs are the lowest of the five impacted communities. Mitigation in Normandy Park is almost evenly split between sound insulation/avigation easements and transportation impacts.

While it may appear to be a high figure, the $2.95 billion does not represent the total potential mitigation amount.

It is important to note that many costs have not yet been determined as part of this study. Primarily, the costs associated with relocating, insulating, and granting easements to select Highline School District facilities was not calculated. Also, costs associated with insulating the Highline Community Hospital were not calculated. Several additional significant environmental and transportation-related impacts should also be calculated prior to construction of the Third Runway.

It is the recommendation of this study that all known environmental, transportation, and socio-economic impacts as identified be mitigated prior to construction of the Third Runway. Multiple additional studies have been identified - mostly to be prepared by the Port of Seattle or its consultants - in order to further clarify the scope of various impacts. All of these studies should be completed prior to the Record of Decision being granted.

This study also recommends ongoing monitoring and mitigation to occur during and after construction, through at least the Year 2020. The five impacted communities should have a voice in this ongoing effort through the recommended "working group/oversight commission".

Finally, in accordance with the GMA, the development of a South King County Comprehensive Plan is strongly urged. This should also involve the City of SeaTac and should integrate all comprehensive planning for the cities, the County, and the Airport into a cohesive, sub-regional document.

APPENDICES

APPENDIX A

EQUITY ISSUES AND SOCIO-ECONOMIC IMPACTS

APPENDIX A
EQUITY ISSUES AND SOCIO-ECONOMIC IMPACTS

A.01 - INTRODUCTION

Equity issues related to the geographic distribution of Seattle-Tacoma International Airport's benefits and costs underpin the requirement for socio-economic impact mitigation. Although a source of contention, it is arguable that socio-economic benefits such as increased economic activity (jobs, income, and output) and social/cultural events (family visits, traveling performance companies and ease of recreational travel) generated by commercial aviation services taking place at Sea-Tac International Airport exceed the Airport's socio-economic costs (noise, traffic congestion, a degraded environment for human habitat, adversely affected educational and social services, and a reduced tax base). However, the benefits are distributed over western Washington and the Puget Sound Region while the costs are localized in a small number of communities immediately surrounding the Airport. Consequently, there is a need for mitigation that redirects some of the Airport's benefits back to the communities that disproportionately bare its costs.

Appendix A looks at the geographic area adversely affected by Sea-Tac International Airport's impacts and compares it to the places of origin of persons initiating commercial air service travel at Sea-Tac International Airport. It also analyses the Airport's economic benefits and how they affect the five impacted communities that are the focus of this study.

The data base for the origin of enplaning passengers at Sea-Tac International Airport comes from a 1991 Origin/ Destination (O/D) study conducted by the Evans-McDonough Company (EMC) for the Port of Seattle (Butler and Kiernan, September 1992). Population estimates used to calculate per capita trip generation rates were from the Washington State Office of Financial Management. Different estimates of the Airport's geographic impact area are derived from studies of Sea-Tac International Airport noise and related impacts conducted for the Port of Seattle during the past decade.

A.02 - GEOGRAPHIC AREA OF SEA-TAC'S ADVERSE IMPACTS

Numerous communities throughout the central Puget Sound region have perceived themselves adversely impacted by some factor (usually noise) connected with Sea-Tac International Airport activity levels, and there is considerable elasticity to the delineation of the geographic area primarily affected. It is widely acknowledged however that the Airport's primary adverse impacts occur in the communities immediately surrounding the Airport.

A Sea-Tac International Airport noise exposure (Part 150) study conducted for the Port of Seattle in 1989 defined the Airport's land use impact area as a rectangle extending approximately 6.2 miles north, 7.0 miles south, 1.2 miles west and 1.6 miles east of the ends of runway 16L/34R (Martin O'Connell Associates, 31 May 1994). The defined area includes all or parts of what are currently the Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila plus parts of South Seattle and parts of unincorporated King County.

A 1994 "Public Building Sound Insulation Project" conducted by the Port of Seattle sent questionnaires to public buildings that might have been adversely impacted by Sea-Tac International Airport's noise. Questionnaires were sent to public buildings located in the Cities of Bellevue, Burien, Des Moines, Federal Way, Kent, SeaTac and Tukwila plus parts of South Seattle and unincorporated King County (Thomas/Lane & Associates, June 1991).

The Port of Seattle's *Final Environmental Impact Statement*, issued February, 1996, defines the "general Study area" for analyzing impacts as a rectangle approximately 7.8 miles north and south and 1.3 miles east and west of the ends of runway 16L/34R. The area includes all or part of the Cities of Burien, Des Moines, Federal Way, Kent, Normandy Park, SeaTac and Tukwila plus parts of South Seattle and unincorporated King County.

The Airport Communities Coalition (ACC) consists of general and special purpose local governments that have organized in opposition to the proposed Sea-Tac International Airport expansion, and they see themselves, collectively, as the primary area affected by the Airport's adverse impacts. ACC members include the Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila plus the Highline School District.

The five Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila covered by this SeaTac Impact Mitigation Study are clearly within the area most adversely impacted by SeaTac International Airport's operations, and they (together with the Highline School District) constitute the focus of this socio-economic analysis.

A.03 - GEOGRAPHIC DISTRIBUTION OF PASSENGERS ORIGINATING TRIPS AT SEA-TAC

The O/D study conducted by EMC is 1991 contains responses from 3,278 originating passengers (Butler and Kiernan, September 1992). Respondents were not required to answer all questions contained in the survey. There were 3,170 responses on the data disk obtained from the Port of Seattle with usable information about trip purposes and trip origins. Respondents were asked the ZIP Code of the place where they spent the prior night (the *place of origin* of the trip). The ZIP Code locations were converted to city and town locations using a US Post Office ZIP Code manual. Table A.01 shows the distribution of respondents originating their trips at home, at a hotel/motel or at a business office.

Table A.01
Trip Origins of Survey Respondents

Place of Trip Origin	Number	Percent
Home	1,856	58.5%
Hotel/motel	830	26.2%
Business office	484	15.3%
Total Respondents	**3,170**	**100.0%**

(Source: Evans-McDonough Company)

The Central Puget Sound region accounted for almost three quarters (71.9%) of all trip respondents in the survey.

Passengers Originating Trips At Home

The majority (58.5%) of persons originating the air portion of their trips at Sea-Tac International Airport went to the airport directly from home. Almost two-thirds (61.2%) of travelers going to the Airport directly from home were traveling for pleasure while the remaining one-third (38.8%) were traveling for business. Table A.02 presents the geographic distribution of passengers who went to the airport directly from home and who originated the air portion of their trip at Sea-Tac International Airport.

Table A.02
Counties of Home Originating Travelers

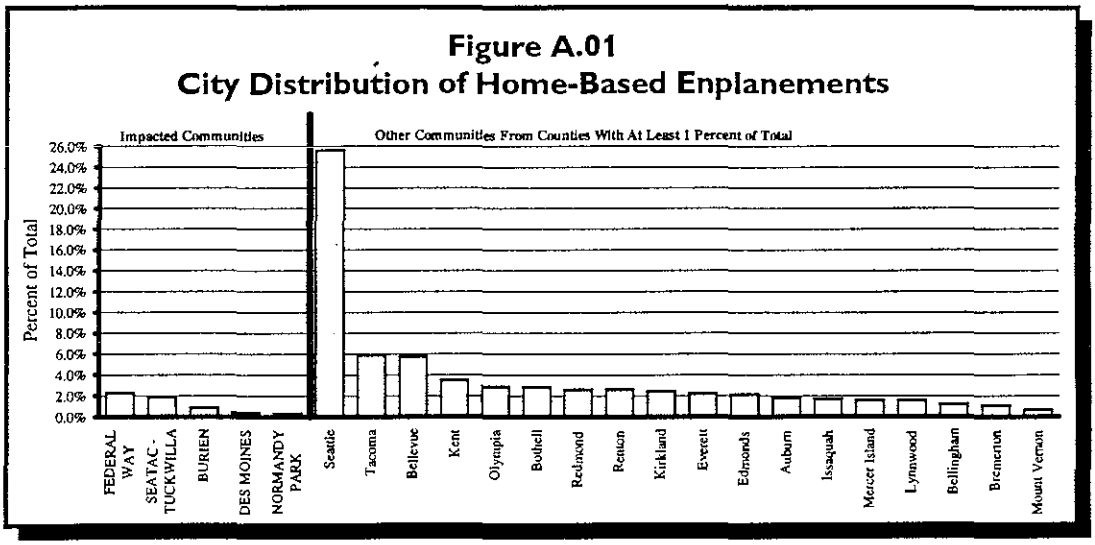
Area	Percent of Total Originating Enplanements
King County (excluding impacted communities)	57.2%
Pierce County	10.4%
Snohomish County	10.1%
Five Impacted Communities Combined	**5.9%**
Thurston County	3.1%
Kitsap County	3.1%
Rest of Washington State	10.2%

(Source: Evans-McDonough Company)

The five impacted cities immediately surrounding the airport that are the focus of this study accounted for 5.9% of these enplanements. King County (excluding the five impacted communities) accounted for 57.2%. Pierce County and Snohomish County accounted for 10.4% and 10.1%, respectively. In terms of large aggregates of places, King County (excluding the five impacted communities) plus Pierce, Snohomish, Thurston and Kitsap counties accounted for 83.9% of home originating enplanements; the rest of Washington State accounted for 10.2% and the five impacted communities combined accounted for 5.9%.

Figure A.01 compares the geographic distribution of home originating enplanements of the five impacted communities with other cities and towns located in Washington counties which generated at least 1.5% of total home originating enplanements. The Cities of Seattle (25.6%), Tacoma (5.9%), Bellevue (5.8%), Kent (3.5%), Olympia (2.9%), Bothell (2.9%), Redmond (2.6%), Renton (2.6%) and Kirkland (2.5%) all account for a larger percentage of total home originating enplanements than do *any* of the five impacted communities. Bellingham, located in Whatcom County and over 100 miles away from the airport generates a larger percentage of home originating enplanements than does Burien. Mount Vernon, located in Skagit County and approximately 75 miles from the Airport generates a larger proportion of home-based enplanements than do either Des Moines or Normandy Park.

Figure A.01
City Distribution of Home-Based Enplanements



Passengers Originating Trips At Hotels and Motels

Approximately a quarter (26.2%) of persons originating the air portion of their trips at Sea-Tac International Airport went to the Airport directly from a hotel or motel. Just over one-quarter (25.7%) of travelers going to the Airport directly from a hotel or motel were traveling for pleasure while three-quarters (74.3%) were traveling for businesses purposes.

Trip departures from hotels and motels are highly concentrated, reflecting the concentration of hotel and motel rooms in the region. King County (excluding the impacted communities) accounted for over half (55.9%) of all persons going to Sea-Tac International Airport directly from a hotel or motel. Within King County (excluding the five impacted communities), just over three-quarters (75.6%) of all trips originating at a hotel or motel were in the City of Seattle; and within Seattle, a single downtown ZIP Code (98101) accounted for almost half (49.0%) of the City's total hotel/motel originating trips.

The impacted communities immediately surrounding the airport accounted for an additional one-third (32.8%) of all persons going to Sea-Tac International Airport directly from a hotel or motel. Within the impacted communities, most of the trips to Sea-Tac International Airport (90.8%) originating at a hotel or motel came from the SeaTac/Tukwila area; and within the SeaTac-Tukwila area, a single ZIP code immediately to the east of the Airport along Pacific Highway South/International Boulevard (ZIP code 98188) accounted for almost three-quarters (72.5%) of the area's total hotel/motel originating trips.

Table A.03
Counties of Hotel and Motel Originating Travelers

Area	Percent of Total Originating Enplanements
King County (excluding impacted communities)	55.9%
Five Impacted Communities Combined	**32.8%**
Pierce County	2.9%
Snohomish County	2.5%
Kitsap County	1.1%
Thurston County	1.0%
Rest of Washington State	3.9%

(Source: Evans-McDonough Company)

Passengers Originating Trips At Business Offices

Almost one of six persons (15.3%) originating the air portion of their trip at Sea-Tac International Airport went to the Airport directly from a business office. Fewer than one in five travelers (17.5%) going to the Airport directly from a business office were traveling for pleasure while more than four of five (82.5%) were traveling for businesses purposes.

Enplanements originating at business offices are highly concentrated in King County (excluding the impacted communities), which accounts for just under two-thirds (66.1%) of the travelers. The impacted communities accounted for an additional 12.4%, and no other county accounted for over 10%.

Figure A.02
City Distribution of Hotel/Motel Based Enplanements

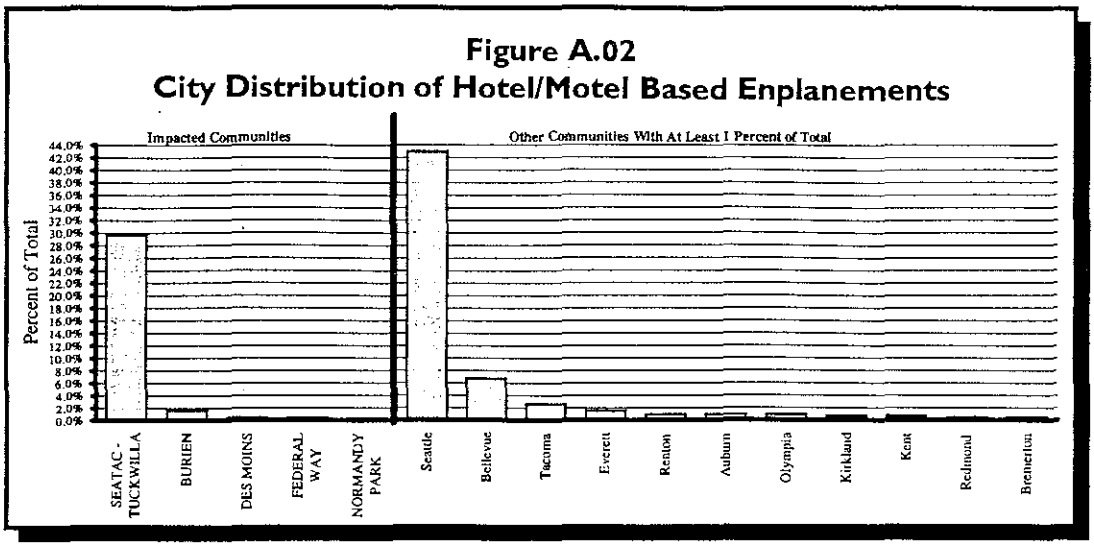


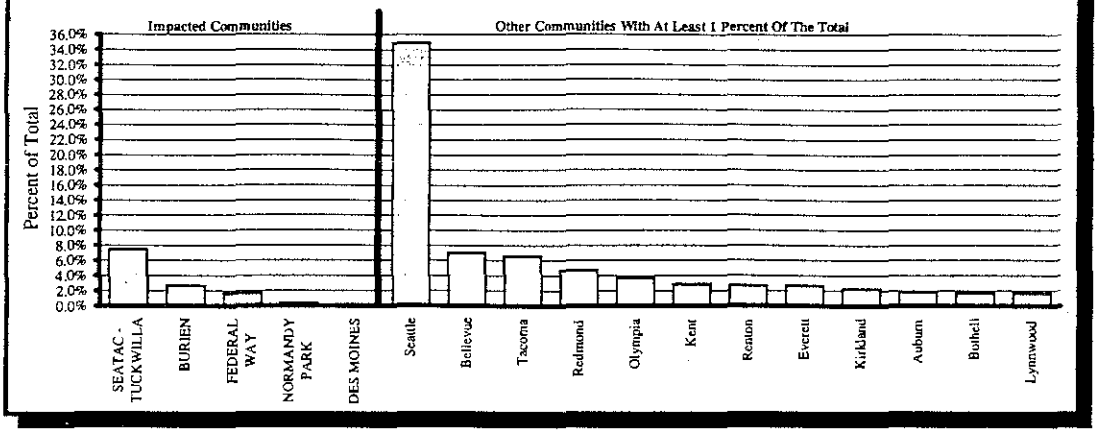
Table A.04
Counties of Business Office Originating Travelers

Area	Percent of Total Originating Enplanements
King County (excluding impacted communities)	66.1%
Five Impacted Communities Combined	**12.4%**
Pierce County	7.9%
Snohomish County	6.0%
Thurston County	3.7%
Kitsap County	0.6%
Rest of Washington State	3.3%

(Source: Evans-McDonough Company)

Within King County (excluding the impacted communities), the City of Seattle accounted for 58.0% of all enplanements originating at a business office, and a single downtown ZIP Code (98101) accounted for almost one-third (30.6%) of Seattle's business office originating enplanements. This pattern of concentrated business office originating enplanements was even more pronounced in the impacted communities. Over two-thirds (69.2%) of the business office originating enplanements generated within the impacted communities occurred in the SeaTac-Tukwila area, and a single ZIP Code (98188 - the same ZIP Code in which hotel/motel originating enplanements were concentrated) accounted for almost all (97.2%) of SeaTac-Tukwila's business office originating enplanements. The pattern of city concentration of business originating enplanements is shown in Figure A.03.

Figure A.03
City Distribution of Business Office Originating Enplanements



A.04 - GEOGRAPHIC DISTRIBUTION OF PER CAPITA ORIGINATING ENPLANEMENTS

Dividing the number of originating enplanements in a community by the community's population and multiplying by 10,000 gives the number of home-originating trips per 10,000 population by community. The 1991 survey of originating enplanement data were divided by the State of Washington's 1991 community population estimates for the analysis of per capita originating enplanements (Butler and Kiernan, September 1992).

Per Capital Home Originating Enplanements

King County (excluding the impacted communities) generated 7.7 originating enplanements per 10,000 population. The impacted communities (combined) generated 6.8 originating enplanements per 10,000 population. No other place in the state generated over 4.0 originating enplanements per 10,000 population.

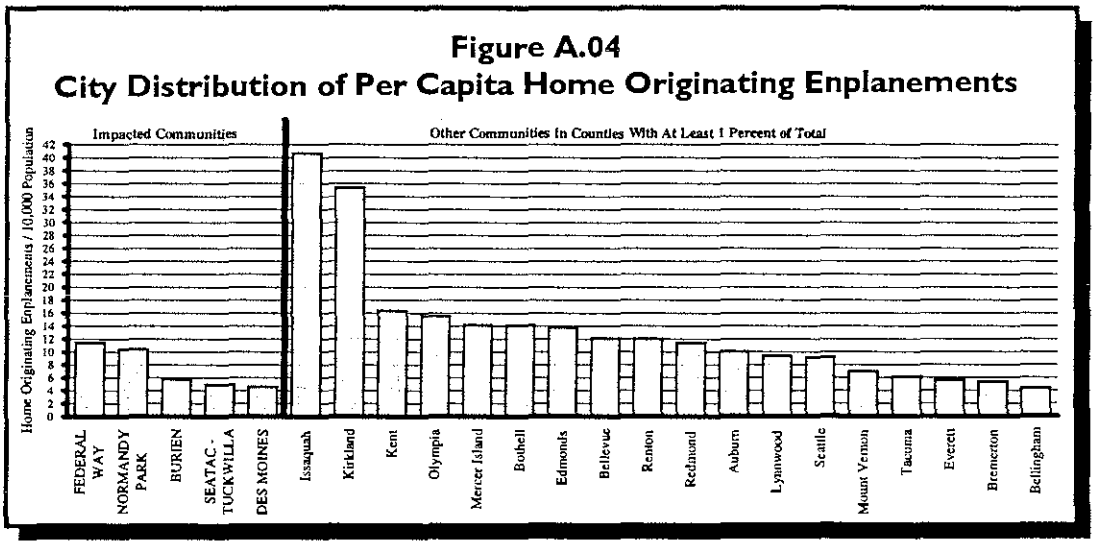
Figure A.03 shows the home trips per 10,000 population of cities and towns in counties which accounted for at least 1% of total statewide home originating enplanements. Among the impacted communities, the highest rate occurred in Federal Way at 11.5 home originating enplanements per 10,000 population. Higher rates occurred in Issaquah (40.7), Kirkland (35.4), Kent (16.4), Olympia (15.5), Mercer Island (14.2), Bothell (14.1), Edmonds (13.8), Bellevue (12.1) and Renton (12.1). The City of Mount Vernon, approximately 75 miles north of Sea-Tac International Airport, had a higher home originating enplanement rate per 10,000 population (6.9) than three of the five impacted communities.

Table A.05
Per Capita Home Originating Travelers

Area	Originating Enplanements Per 10,000 Population
King County (excluding five impacted communities)	7.7
Five Impacted Communities Combined	**6.8**
Snohomish County	3.9
Thurston County	3.5
Pierce County	3.2
Kitsap County	2.9

(Source: Evans-McDonough Company)

Figure A.04
City Distribution of Per Capita Home Originating Enplanements



A.05 - GEOGRAPHIC MISMATCH BETWEEN AIRPORT USER BENEFITS AND COSTS

Various delineation's of Sea-Tac International Airport's primary adverse impact area exist. However, they all identify the communities and unincorporated areas of southwest King County, immediately surrounding the Airport, as the one's which suffer the primary burden of Sea-Tac International Airport's adverse impacts. These communities are impacted by the Airport's non-market costs, such as noise pollution, visual degradation, surface traffic congestion and air quality decline.

Non-market costs refer to costs resulting from operation of the Airport which are not incorporated in the price Airport users have to pay for air transportation services. They represent a transfer of value *from* persons living in the immediate vicinity of the Airport *to* persons using the air transportation services provided at the Airport. If the same persons that suffer the Airport's primary non-market adverse impacts were either its primary users or the primary recipients of its non-market benefits, (Shapiro and Associates, April 1994), benefits and costs would be roughly in-line and no equity issue would exist.

However, an analysis of Airport users' residential and business locations reveals a "disconnect" between the Airport's benefits and costs. The five ACC communities plus the City of SeaTac, combined, account for only 5.9% of all Sea-Tac International Airport enplanements originating at the traveler's home. Cities such as Bellingham - located over 100 miles to the north of the Airport - generate a larger percentage of home originating enplanements than three of the impacted communities. The City of Seattle accounts for over four times the number of home originating enplanements than do all the impacted communities combined. In terms of per capita rates, the Cities of Issaquah, Kirkland, Kent, Olympia, Mercer Island, Bothell, Edmonds, Bellevue and Renton all generated more home originating enplanements per 10,000 population than did any of the impacted communities.

The City of Mount Vernon, approximately 75 miles to the north, had a higher home originating enplanement rate than three of the five impacted communities. The rate of home originating enplanements per 10,000 population for all the impacted communities combined was less than the rate for the rest of King County (6.8 compared to 7.7, respectively).

In terms of persons who live in the region, the impacted communities represent a small fraction of enplanements and they generate a lower rate of participation in flying than does the rest of King County.

Turning to business benefits reflected by enplanements originating from hotels, motels and business offices, the area directly east of Sea-Tac International Airport along Pacific Highway South/International Boulevard generates the second largest concentration of hotel/motel originating enplanements in the region - after downtown Seattle. Even a casual inspection of the area shows these hotel/motel originating enplanements to be concentrated directly across from Sea-Tac International Airport's terminal.

Enplanements originating from business offices are disproportionately concentrated in King County (excluding the impacted communities) which accounts for almost two-thirds (66.1%) of such enplanements. The combined impacted communities account for only 12.4% of these types of enplanements. Again, most of the business enplanements originating from the impacted communities come from the area directly east of Sea-Tac International Airport along Pacific Highway South/International Boulevard.

In terms of business activity related to the Airport, the distribution of originating enplanements shows that the City of SeaTac gets some significant business activity (particularly guests at its motels), but the Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila receive little business related benefit from the Airport.

Overall, residents of the communities immediately surrounding the Airport get disproportionately small benefits (both in total and per capita terms) from their use of the Airport while suffering disproportionately large costs. Business activity generated by the Airport appear to produce significant benefit for the City of SeaTac but little benefit for the Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila.

Comparing geographic areas which receive the major benefits of Sea-Tac International Airport's air transportation services with those that suffer the primary costs (adverse impacts) leads to the inescapable conclusion that a large discrepancy exists between the costs suffered and benefits received by residents of Burien, Des Moines, Federal Way, Normandy Park and Tukwila. The discrepancy results in a lack of equity between residents of the region who primarily benefit from the Airport and residents who primarily suffer its socio-economic costs. It causes an imbalance between populations that benefit and that suffer the cost of Sea-Tac International Airport as a major aviation center. It is an imbalance that necessitates socio-economic mitigation by the Port of Seattle to redress.

A.06 - GEOGRAPHIC MISMATCH BETWEEN OTHER AIRPORT BENEFITS AND COSTS

An additional benefit attributable to Sea-Tac International Airport is the jobs (and income) it creates. Table A.06 shows the number of direct jobs created at Sea-Tac International Airport held by residents of the five impacted cities, and the percent of all jobs held by residents of the five impacted cities that they account for. Table A.07 shows the same information but for the indirect jobs created by the Airport in the City of SeaTac.

Table A.06
Direct Jobs Created at Sea-Tac International Airport Held by Residents of the Five Impacted Cities

City	Total Work-Trips to Airport	Total Resident Workers	Airport Work-Trips As Percent of Resident Workers
Federal Way	911	40,001	2.28%
Des Moines	436	14,576	2.99%
Burien	341	17,312	1.97%
Normandy Park	154	2,688	5.73%
Tukwila	125	7,652	1.63%

(Source: Census Transportation Planning Package)

Table A.07
Indirect Jobs Created at City of SeaTac Held by Residents of the Five Impacted Cities

City	Total Work-Trips to City of SeaTac	Total Resident Workers	SeaTac Work-Trips As Percent of Resident Workers
Federal Way	1,299	40,001	3.25%
Des Moines	756	14,576	5.19%
Burien	582	17,312	3.36%
Tukwila	232	7,652	3.03%
Normandy Park	193	2,688	7.18%

(Source: Census Transportation Planning Package)

The analysis of Sea-Tac International Airport's direct and indirect job impacts was conducted on information provided by the Puget Sound Regional Council (PSRC) from two special data runs on the 1990 Census Transportation Planning Package (CTPP). One data run on the CTTP provided the number of work trips with origins in the Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila that had destinations at Sea-Tac International Airport (Traffic Analysis Zone 355). The second run provided the same information for work trips that had destinations in the 13 Traffic Analysis Zones (TAZs) that lie within the City of SeaTac.

As can be seen from Table A.06, the percentage of resident workers in the five impacted communities covered by this study with direct jobs at the Airport is low - ranging from 1.63% in Tukwila to 5.73% in Normandy Park. For the five cities combined, the percent of resident workers with jobs directly at the Airport is 2.39%. The percent of City of SeaTac residents with jobs in the Airport's TAZ is 3.29%.

Table A.07 presents similar information, only for residents of the five impacted cities whose work trips have destinations in the City of SeaTac. The data in Table A.07 are presented because the City of SeaTac contains the second largest concentration of hotel/motel rooms in the region where air travelers stay immediately before departing on their trip; and might be a significant source of indirect Airport jobs for residents of the five impacted cities. As Table A.07 shows, however, this is not the case. Even if all residents of the five impacted cities working in the City of SeaTac held indirect Airport jobs, the percent of residents affected would vary from a high of 7.18% in Normandy Park to a low of 3.03% in Tukwila. For the five impacted cities combined, the maximum percent of residents with Airport jobs is 3.72%.

More likely, the proportion is between half to three-quarters. Using the upper end of this range (0.75%), the combined direct plus indirect jobs generated by the Airport equals 5.18% of the combined resident workers in the five impacted communities.

The final way in which Sea-Tac International Airport might generate benefits to the five impacted cities is through their collection of property, sales and business and occupation (B&O) taxes. For the City of SeaTac, such taxes may be a large contribution to the city's fiscal health since it contains numerous hotels, motels and office buildings which likely would not be there if not for the Airport. Additionally, the city collects taxes for automobiles that park at Sea-Tac International Airport's parking garage. The Highline School District collects business personal property taxes from the commercial airlines that operate out of Sea-Tac International Airport. The five impacted cities studied in this report plus the Highline School District all experience reduced residential property tax collections as a result of the Airport (as is discussed previously in this report) and with the few jobs and income produced by the Airport that go to residents of the five impacted cities, it is highly likely that the net effect of the Airport on tax revenue collections in the five affected cities is negative. The question of Airport-generated tax revenues in the affected cities can only be roughly estimated since the topic was not addressed in the Master Plan Update EIS and there are not any readily available sources for making estimates. Based on available data describing the travel industry, direct job and indirect job impacts generated by the Airport, it does not appear likely that Sea-Tac International Airport produces significant tax benefits for the five impacted cities.

A.07 - SUMMARY OF AIRPORT GENERATED BENEFITS AND COSTS

The working assumption of this Sea-Tac International Airport Impact Mitigation Study is that the total benefits which will result from expansion of the Airport are greater than the total costs that will be incurred. Viewed from the perspective of the entire Puget Sound region or the State of Washington, there is justification for Sea-Tac International Airport's expansion. The benefits of the Airport's expansion however are spread over the entire state and region. Relatively few of these benefits go to residents of the five Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila. Whether benefits are measured in terms of time saving to the traveling public, direct and indirect jobs (and income) created, or tax revenues generated, the vast majority of benefits go to persons who do not reside in the five impacted cities that are the focus of this study.

On the other hand, there is evidence that the adverse socio-economic impacts (costs) of the Airport are concentrated in the five Cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila. From the perspective of these cities, the Airport's benefits are far less than its costs.

If Sea-Tac International Airport is to be expanded, consequently, equity demands that these cities be made whole by actions designed to mitigate the Airport's adverse socio-economic impacts and re-establish some balance between the benefits and costs which these cities will face. The fact that the Airport's total benefits exceed its total costs means that there is a margin available for such mitigation. What is required is public policy that both recognizes the magnitude of the equity issue and directs sufficient resources to restore a balance between benefits and costs facing the five impacted cities and the Highline School District.

APPENDIX B
TECHNICAL REFERENCES

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APPENDIX C
PROJECT CONTACTS

APPENDIX C
PROJECT CONTACTS

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City of SeaTac, Washington
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City of Burien Planning Commission
Highline School District
Regional Council on Airport Affairs

APPENDIX D
GLOSSARY OF TERMS

APPENDIX D
GLOSSARY OF TERMS

A

AADT	Average annual daily traffic
AAQS	Ambient Air Quality Standards
AASA	Aging & Adult Services Administration
ACC	Airport Communities Coalition
AIRTRACT	Washington State Air Transportation Commission
ASIL	Acceptable Source Impact Level
ASV	Annual Service Volume
ATC	Air traffic control

B

(none)

C

CAA	Clean Air Act
CAL3QHC	Air quality computer model
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cm	Centimeter
CMS	Congestion Management System
CNEL	Community Noise Equivalent Level
CO	Carbon monoxide
COE	United States Army Corps of Engineers
CPS	Cycles per second (same as "Hertz")
CTBS	Comprehensive Test of Basic Skills
CTED	Washington Department of Community, Trade, and Economic Development
CTI	Cell Therapeutics Inc. campus (proposed)
CTPP	Census Transportation Planning Package

D

DASA	Division of Alcohol & Substance Abuse
dB	Decibel
dBA	A-weight decibel
DCFS	Division of Children & Family Services
DDD	Division of Developmental Disabilities
DEIS	Draft Environmental Impact Statement
DFW	Dallas/Fort Worth International Airport
DIA	Denver International Airport
DOE	Washington Department of Ecology
DSHS	Washington Department of Social and Health Services
DU	Dwelling unit
DVR	Division of Vocational Rehabilitation

E

EDMS	Emissions and Dispersion Modeling System
EIS	Environmental Impact Statement
ESA	Economic Services Administration
ESL	English as a Second Language

F

FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FHWA	Federal Highway Administration

G

GA	General aviation
GIS	Geographic information system
GMA	Growth Management Act
GPS	Global Positioning Satellite System

H

HC Hydrocarbon
HOV High-occupancy vehicles
Hz Hertz (or cycles per second)

I

IH Interstate Highway
ILS Instrument landing system
INM Integrated Noise Model
ISO International Organization for Standardization
IWS Industrial Waste System

J

JRA Juvenile Rehabilitation Administration

K

(none)

L

LDN Average Day/Night Sound Level (generally associated with aviation activity)
LEQ Average Daily Sound Level (generally associated with surface transportation activity)
LOS Level of Service

M

$\mu g/m^3$	Micrograms per cubic meter
MCY	Million cubic yards
MHD	Mental Health Division
MLS	Microwave Landing System
MOA	Memorandum of Understanding
MOBILESA	Mobile source emission program from US EPA
MSA	Medical Assistance Administration

N

NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_2	Nitrogen dioxide
NOISEMAP	Aircraft noise model developed by the US Air Force
Northflow	Departure traffic to the north, arriving traffic from the south

O

O_3	Ozone
OAG	Official Airline Guide
O-D	Origin-destination survey
OFM	Office of Financial Management, King County Assessor's Office

P

$PM_{2.5}$	Particulate matter (2.5 microns or less)
PM_{10}	Particulate matter (10 microns or less)
PNA	Polynuclear aromatic
ppm	Parts per million
Port	Port of Seattle
POS	Port of Seattle
PSAPCA	Puget Sound Air Pollution Control Agency
PSRC	Puget Sound Regional Council

Q

(none)

R

ROD Record of Decision
RPZ Runway protection zone
RUSLE Revised Universal Soil Loss Equation
RTA Regional Transit Authority

S

Sea-Tac Seattle-Tacoma International Airport
SEL Single-Event Noise Levels
SEPA Washington State Environmental Protection Agency and Washington State Environmental Policy Act
SASA South Aviation Support Area
SAT Scholastic Aptitude Test
STAMINA Computer noise model for roadway noise
SDS Storm Drain System
SH State Highway
SI Serviceability index
SIP Statewide Implementation Program
SO_2 Sulfur dioxide
Southflow Departure traffic to the south, arriving traffic from the north
SPCC Spill Prevention, Control and Countermeasure Plan
SR State Route

T

TA Threshold Analysis (also referred to as Time Above)
TAZ Traffic Analysis Zone
TRACON Terminal radar control area
TRB Transportation Research Board
TSM Transportation System Management
TSS Total suspended solids

U

URAA Uniform Relocation Assistance Act
USDOT United States Department of Transportation
USEPA United States Environmental Protection Agency

V

V/C Volume/capacity ratio
VOC Volatile organic compound

W

WAC Washington Administrative Code
WATERWORKS Hydraulic analysis computer program
WISHA Washington Industrial and Safety Health Act
WPPSS Washington Public Power Supply System

X

(none)

Y

(none)

Z

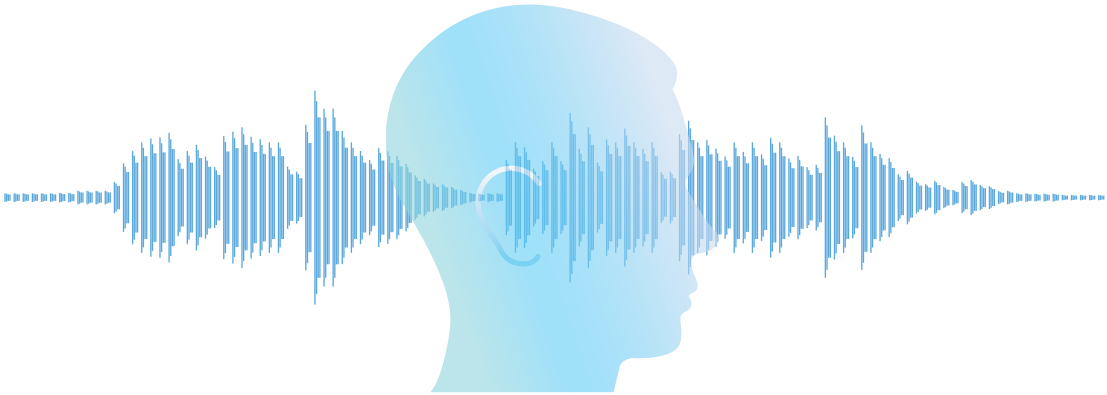
(none)

NOTES

World Health Organization
REGIONAL OFFICE FOR Europe

ENVIRONMENTAL NOISE GUIDELINES

for the European Region



Abstract

Noise is an important public health issue. It has negative impacts on human health and well-being and is a growing concern. The WHO Regional Office for Europe has developed these guidelines, based on the growing understanding of these health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. They provide robust public health advice underpinned by evidence, which is essential to drive policy action that will protect communities from the adverse effects of noise. The guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience.

Keyword

NOISE – ADVERSE EFFECTS, PREVENTION AND CONTROL

ENVIRONMENTAL EXPOSURE – ADVERSE EFFECTS, PREVENTION AND CONTROL

GUIDELINES

EUROPE

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Environmental Noise Guidelines for the European Region

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Foreword

Noise is one of the most important environmental risks to health and continues to be a growing concern among policy-makers and the public alike. Based on the assessment threshold specified in the Environmental Noise Directive of the European Union (EU), at least 100 million people in the EU are affected by road traffic noise, and in western Europe alone at least 1.6 million healthy years of life are lost as a result of road traffic noise.

At the request of Member States at the Fifth Ministerial Conference on Environment and Health in Parma, Italy, in March 2010, the WHO Regional Office for Europe has developed these guidelines, based on the growing understanding of the health impacts of exposure to environmental noise. They provide robust public health advice, which is essential to drive policy action that will protect communities from the adverse effects of noise.

These WHO guidelines – the first of their kind globally – provide recommendations for protecting human health from exposure to environmental noise originating from various sources. They not only offer robust public health advice but also serve as a solid basis for future updates, given the growing recognition of the problem and the rapid advances in research on the health impacts of noise. The comprehensive process of developing the guidelines has followed a rigorous methodology; their recommendations are based on systematic reviews of evidence that consider more health outcomes of noise exposure than ever before. Through their potential to influence urban, transport and energy policies, these guidelines contribute to the 2030 Agenda for Sustainable Development and support WHO's vision of creating resilient communities and supportive environments in the European Region.

Following the publication of WHO's community noise guidelines in 1999 and night noise guidelines for Europe in 2009, these latest guidelines represent the next evolutionary step, taking advantage of the growing diversity and quality standards in this research domain. Comprehensive and robust, and underpinned by evidence, they will serve as a sound basis for action. While these guidelines focus on the WHO European Region and provide policy guidance to Member States that is compatible with the noise indicators used in the EU's Environmental Noise Directive, they still have global relevance. Indeed, a large body of the evidence underpinning the recommendations was derived not only from noise effect studies in Europe but also from research in other parts of the world – mainly in Asia, Australia and the United States of America.

I am proud to present these guidelines as another leading example of the normative work undertaken in our Region in the area of environment and health. On behalf of the WHO Regional Office for Europe and our European Centre for Environment and Health in Bonn, Germany, which coordinated the development of the guidelines, I would like to express my gratitude to the large network of experts, partners, colleagues and consultants who have contributed to this excellent publication. I would also like to thank Switzerland and Germany for providing financial support to this complex project, and look forward to following the influence of the guidelines on policy and research in the years to come.

Dr Zsuzsanna Jakab

WHO Regional Director for Europe

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The WHO Regional Office for Europe, through its European Centre for Environment and Health, coordinated the development of these guidelines. The project was coordinated by Marie-Eve Héroux and Dorota Jarosinska, under the overall supervision of Elizabet Paunovic, Head of the European Centre for Environment and Health.

The members of the Steering Group were: Shelly Chadha, Carlos Dora, Rokho Kim, Jurgita Lekaviciute, Srdan Matic, Julia Nowacki, Poonum Wilkhu and Joerdis Wothge (see Annex 1 Table A1.1 for affiliations).

The members of the Guideline Development Group were: Stephen Stansfeld (Chair), Wolfgang Babisch, Goran Belojevic, Mark Brink, Sabine Janssen, Peter Lercher (2013–2014), Marco Paviotti, Göran Pershagen, Kerstin Persson Waye, Anna Preis, Martin van den Berg and Jos Verbeek (methodologist) (see Annex 1 Table A1.2 for affiliations).

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Abbreviations

%HA	percentage of the population “highly annoyed”
%HSD	percentage of the population “highly sleep-disturbed”
BMI	body mass index
CI	confidence interval
CNG	WHO guidelines for community noise
DALY	disability-adjusted life-year
dB	decibel
DW	disability weight
EC	European Commission
EEA	European Environment Agency
END	European Union Directive 2002/49/EC relating to the assessment and management of environmental noise (Environmental Noise Directive)
ERF	exposure–response function
EU	European Union
GDG	Guideline Development Group
GRADE	Grading of Recommendations Assessment Development and Evaluation
ICBEN	International Commission on Biological Effects of Noise
IHD	ischaemic heart disease
JRC	Joint Research Centre [of the European Commission]
mmHg	milimeters of mercury
NNG	WHO night noise guidelines for Europe
OR	odds ratio
PECCOS	population, exposure, comparator, confounder, outcome and study [framework]
PICOS	population, intervention, comparator, outcome and study [framework]
PLD	personal listening device
RANCH	Road traffic and aircraft noise exposure and children’s cognition and health [study]
RCT	randomized control trial
RR	relative risk
SCENIHR	Scientific Committee on Emerging and Newly Identified Hazards and Risk

Glossary of acoustic terms

A-weighting	A frequency-dependent correction that is applied to a measured or calculated sound of moderate intensity to mimic the varying sensitivity of the ear to sound for different frequencies
C-weighting	A frequency-dependent correction that is applied to a measured or calculated sound of moderate intensity to mimic the varying sensitivity of the ear to sound for different frequencies – C-weighting is usually used for peak measurements
FAST	Fast response has a time constant of 125 milliseconds on a sound level meter
$L_{Aeq,T}$	A-weighted, equivalent continuous sound pressure level during a stated time interval starting at t_1 and ending at t_2, expressed in decibels (dB), at a given point in space[1]
$L_{A,max}$	Maximum time-weighted and A-weighted sound pressure level within a stated time interval starting at t_1 and ending at t_2, expressed in dB[1]
L_{AF}	A-weighted sound pressure level with FAST time constant as specified in IEC 61672-1[1]
$L_{AF,max}$	Maximum time-weighted and A-weighted sound pressure level with FAST time constant within a stated time interval starting at t_1 and ending at t_2, expressed in dB
$L_{AS,max}$	Maximum time-weighted and A-weighted sound pressure level with SLOW time constant within a stated time interval starting at t_1 and ending at t_2, expressed in dB
L_E	Sound energy density level is the logarithmic ratio of the time-averaged sound energy per unit volume to the reference sound energy density Eo = 10-12 J/m^3.
$L_{ex,8h}$	L_{eq} (equivalent continuous sound level) corrected for the length of the working shift, in this case 8 hours
L_{day}	Equivalent continuous sound pressure level when the reference time interval is the day[1]
L_{den}	Day-evening-night-weighted sound pressure level as defined in section 3.6.4 of ISO 1996-1:2016[1]
L_{dn}	Day-night-weighted sound pressure level as defined in section 3.6.4 of ISO 1996-1:2016[1]
$L_{evening}$	Equivalent continuous sound pressure level when the reference time interval is the evening[1]

[1] *Source*: ISO (2016).

L_{night}	Equivalent continuous sound pressure level when the reference time interval is the night[1]
$L_{peak,C}$	Level of peak sound pressure with C-weighting, within a specified time interval
$L_{peak,lin}$	Level of peak sound pressure with linear frequency weighting, within a specified time interval
Sound pressure level	the logarithm of the ratio of a given sound pressure to the reference sound pressure in dB is 20 times the logarithm to the base ten of the ratio.
SLOW	Slow response has a time constant of 10 000 milliseconds on a sound level meter

Executive summary

Environmental noise is an important public health issue, featuring among the top environmental risks to health. It has negative impacts on human health and well-being and is a growing concern among both the general public and policy-makers in Europe.

At the Fifth Ministerial Conference on Environment and Health in Parma, Italy, in 2010, WHO was requested by the Member States in the European Region to produce noise guidelines that included not only transportation noise sources but also personal electronic devices, toys and wind turbines, which had not yet been considered in existing guidelines. Furthermore, European Union Directive 2002/49/EC relating to the assessment and management of environmental noise (END) and related technical guidance from the European Environment Agency both elaborated on the issue of environmental noise and the importance of up-to-date noise guidelines.

The WHO Regional Office for Europe has therefore developed environmental noise guidelines for the European Region, proposing an updated set of public health recommendations on exposure to environmental noise.

Objectives

The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. Leisure noise in this context refers to all noise sources that people are exposed to due to leisure activities, such as attending nightclubs, pubs, fitness classes, live sporting events, concerts or live music venues and listening to loud music through personal listening devices. The guidelines focus on the WHO European Region and provide policy guidance to Member States that is compatible with the noise indicators used in the European Union's END.

The following two key questions identify the issues addressed by the guidelines.

- In the general population exposed to environmental noise, what is the exposure–response relationship between exposure to environmental noise (reported as various indicators) and the proportion of people with a validated measure of health outcome, when adjusted for confounders?
- In the general population exposed to environmental noise, are interventions effective in reducing exposure to and/or health outcomes from environmental noise?

In light of these questions, the guidelines set out to define recommended exposure levels for environmental noise in order to protect population health.

Methods used to develop the guidelines

The process of developing the WHO guidelines followed a rigorous methodology involving several groups with separate roles and responsibilities. Throughout the process, the Grading of

Recommendations Assessment, Development and Evaluation (GRADE) approach was followed. In particular, the different steps in the development of the guidelines included:

- formulation of the scope and key questions of the guidelines;
- review of the pertinent literature;
- selection of priority health outcome measures;
- a systematic review of the evidence;
- assessment of certainty of the bodies of evidence resulting from systematic reviews;
- identification of guideline exposure levels; and
- setting of the strength of recommendations.

Based on the defined scope and key questions, these guidelines reviewed the pertinent literature in order to incorporate significant research undertaken in the area of environmental noise and health since the community noise guidelines and night noise guidelines for Europe were issued (WHO, 1999; WHO Regional Office for Europe, 2009). In total, eight systematic reviews of evidence were conducted to assess the relationship between environmental noise and the following health outcomes: cardiovascular and metabolic effects; annoyance; effects on sleep; cognitive impairment; hearing impairment and tinnitus; adverse birth outcomes; and quality of life, mental health and well-being. A separate systematic review of evidence was conducted to assess the effectiveness of environmental noise interventions in reducing exposure and associated impacts on health.[2] Once identified and synthesized, the quality of the evidence of the systematic reviews was assessed by the Systematic Review Team. Subsequently, the Guideline Development Group (GDG) formulated recommendations, guided by the Systematic Review Team's assessment and informed by of a number of additional contextual parameters. To facilitate the formulation of recommendations, the GDG first defined priority health outcomes and then selected the most relevant health outcome measures for the outcomes. Consecutively, a process was developed to identify the guideline exposure levels with the help of the exposure–response functions provided by the systematic reviews. To reflect the nature of the research (observational studies) underpinning the relationship between environmental noise and health, the GRADE procedures were adapted to the requirements of environmental exposure studies where needed.

Noise indicators

From a scientific point of view, the best noise indicator is the one that performs best in predicting the effect of interest. There are, however, a number of additional criteria that may influence the choice of indicator. For example, various indicators might be suitable for different health end-points. Some considerations of a more political nature can be found in the European Commision's Position paper on EU noise indicators (EC, 2000).

[2] All systematic reviews are publicly available online in the *International Journal of Environmental Research and Public Health*. A detailed list of links to the individual reviews is provided in section 2.3.2 and in Annex 2 of these guidelines.

The current guidelines are intended to be suitable for policy-making in the WHO European Region. They therefore focus on the most used noise indicators L_{den} and/or L_{night} (see the glossary of acoustic terms for further details). They can be constructed using their components (L_{day}, $L_{evening}$, L_{night} and the duration in hours of L_{night}), and are provided for exposure at the most exposed façade, outdoors. The L_{den} and L_{night} indicators are those generally reported by authorities and are widely used for exposure assessment in health effect studies.

Recommendations

Specific recommendations have been formulated for road traffic noise, railway noise, aircraft noise, wind turbine noise and leisure noise. Recommendations are rated as either strong or conditional.

Strength of recommendation

- A **strong** recommendation can be adopted as policy in most situations. The guideline is based on the confidence that the desirable effects of adherence to the recommendation outweigh the undesirable consequences. The quality of evidence for a net benefit – combined with information about the values, preferences and resources – inform this recommendation, which should be implemented in most circumstances.
- A **conditional** recommendation requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply.

Alongside specific recommendations, several guiding principles were developed to provide generic advice and support for the incorporation of recommendations into a policy framework. They apply to the implementation of all of the specific recommendations.

Guiding principles: reduce, promote, coordinate and involve

- Reduce exposure to noise, while conserving quiet areas.
- Promote interventions to reduce exposure to noise and improve health.
- Coordinate approaches to control noise sources and other environmental health risks.
- Inform and involve communities potentially affected by a change in noise exposure.

The recommendations, source by source, are as follows.

Road traffic noise

Recommendation	Strength
For average noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic below **53 decibels (dB)** L_{den}, as road traffic noise above this level is associated with adverse health effects.	Strong
For night noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic during night time below **45 dB** L_{night}, as night-time road traffic noise above this level is associated with adverse effects on sleep.	Strong
To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions, the GDG recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure.	Strong

Railway noise

Recommendation	Strength
For average noise exposure, the GDG strongly recommends reducing noise levels produced by railway traffic below **54 dB** L_{den}, as railway noise above this level is associated with adverse health effects.	Strong
For night noise exposure, the GDG strongly recommends reducing noise levels produced by railway traffic during night time below **44 dB** L_{night}, as night-time railway noise above this level is associated with adverse effects on sleep.	Strong
To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from railways in the population exposed to levels above the guideline values for average and night noise exposure. There is, however, insufficient evidence to recommend one type of intervention over another.	Strong

Aircraft noise

Recommendation	Strength
For average noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft below **45 dB** L_{den}, as aircraft noise above this level is associated with adverse health effects.	Strong
For night noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft during night time below **40 dB** L_{night}, as night-time aircraft noise above this level is associated with adverse effects on sleep.	Strong
To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from aircraft in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions the GDG recommends implementing suitable changes in infrastructure.	Strong

Wind turbine noise

Recommendation	Strength
For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below **45 dB** L_{den}, as wind turbine noise above this level is associated with adverse health effects.	Conditional
No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.	
To reduce health effects, the GDG conditionally recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another.	Conditional

Leisure noise

Recommendation	Strength
For average noise exposure, the GDG conditionally recommends reducing the yearly average from all leisure noise sources combined to **70 dB** $L_{Aeq,24h}$ as leisure noise above this level is associated with adverse health effects. The equal energy principle[3] can be used to derive exposure limits for other time averages, which might be more practical in regulatory processes.	Conditional
For single-event and impulse noise exposures, the GDG conditionally recommends following existing guidelines and legal regulations to limit the risk of increases in hearing impairment from leisure noise in both children and adults.	Conditional
Following a precautionary approach, to reduce possible health effects, the GDG strongly recommends that policy-makers take action to prevent exposure above the guideline values for average noise and single-event and impulse noise exposures. This is particularly relevant as a large number of people may be exposed to and at risk of hearing impairment through the use of personal listening devices. There is insufficient evidence, however, to recommend one type of intervention over another.	Strong

Target audience

The guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience, as a large body of the evidence underpinning the recommendations was derived not only from European noise effect studies but also from research in other parts of the world – mainly in America, Asia and Australia.

[3] The equal energy principle states that the total effect of sound is proportional to the total amount of sound energy received by the ear, irrespective of the distribution of that energy in time (WHO, 1999).

1. Introduction

Environmental noise features among the top environmental risks to physical and mental health and well-being, with a substantial associated burden of disease in Europe (WHO Regional Office for Europe & JRC, 2011; Hänninen et al., 2014). It has negative impacts on human health and well-being and is a growing concern among both the general public and policy-makers in Europe.

WHO published community noise guidelines (CNG) and night noise guidelines (NNG) for Europe in 1999 and 2009, respectively (WHO, 1999; WHO Regional Office for Europe, 2009). Since then, significant new evidence has accumulated on the health effects of environmental noise.

The need for updated health-based guidelines originates in part from commitments made at the Fifth Ministerial Conference on Environment and Health in Parma, Italy, in 2010, where Member States asked WHO to produce appropriate noise guidelines that would include additional noise sources such as personal electronic devices, toys and wind turbines (WHO Regional Office for Europe, 2010). Furthermore, European Union (EU) Directive 2002/49/EC relating to the assessment and management of environmental noise (the END – EC, 2002a) and related technical guidance from the European Environment Agency (EEA) both elaborated on the issue of environmental noise and the importance of up-to-date noise guidelines (EEA, 2010).

The WHO Regional Office for Europe has therefore developed environmental noise guidelines for the European Region, proposing an updated set of public health recommendations on exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. The guidelines focus on the WHO European Region and provide policy guidance to Member States that is compatible with the noise indicators used in the EU's END.

The following two key questions identify the issues addressed by the guidelines.

- In the general population exposed to environmental noise, what is the exposure–response relationship between exposure to environmental noise (reported as various indicators) and the proportion of people with a validated measure of health outcome, when adjusted for confounders?
- In the general population exposed to environmental noise, are interventions effective in reducing exposure to and/or health outcomes from environmental noise?

1.1 The public health burden from environmental noise

Exposure to noise can lead to auditory and nonauditory effects on health. Through direct injury to the auditory system, noise leads to auditory effects such as hearing loss and tinnitus. Noise is also a nonspecific stressor that has been shown to have an adverse effect on human health, especially following long-term exposure. These effects are the result of psychological and physiological distress, as well as a disturbance of the organism's homeostasis and increasing allostatic load (Basner et al., 2014). This is further outlined in the WHO narrative review of the biological mechanisms of nonauditory effects (Eriksson et al., 2018).

The evidence of the association between noise exposure and health effects is based on experimental work regarding biological plausibility and, in observational studies, consistency among study results, presence of an exposure–response relationship and the magnitude of the effect. Environmental noise risk assessment and risk management relies on established exposure–response relationships (Babisch, 2014).

In 2011 the WHO Regional Office for Europe and the European Commission (EC) Joint Research Centre (JRC) published a report on the burden of disease from environmental noise that quantified the healthy years of life lost in western Europeam countries as a result of environmental noise (WHO Regional Office for Europe & JRC, 2011). The burden of disease is calculated, in a single measure of disability-adjusted life-years (DALYs), as the sum of the years of life lost from premature mortality and the years lived with disability for people living with the disease or health condition or its consequences in the general population (WHO, 2014a).

Sufficient information was deemed available to quantify the burden of disease from environmental noise for cardiovascular disease, cognitive impairment in children, sleep disturbance, tinnitus and annoyance. The report, based on a limited set of data, estimated that DALYs lost from environmental noise in western European countries are equivalent to 61 000 years for ischaemic heart disease (IHD), 45 000 years for cognitive impairment in children, 903 000 years for sleep disturbance, 22 000 years for tinnitus and 654 000 years for annoyance (WHO Regional Office for Europe & JRC, 2011). These results indicate that at least one million healthy years of life are lost every year from traffic-related environmental noise in western Europe. Sleep disturbance and annoyance, mostly related to road traffic noise, constitute the bulk of this burden. Available assessments place the burden of disease from environmental noise as the second highest after air pollution (WHO Regional Office for Europe & JRC, 2011; Hänninen et al., 2014; WHO 2014b). However, a lack of noise exposure data in the central and eastern parts of the WHO European Region means that it is not possible to assess the burden of disease from environmental noise for the whole Region.

1.2 The environmental noise policy context in the EU

The EU has been working to develop a harmonized noise policy for more than two decades. 1993 saw the start of the EC's Fifth Environment Action Programme, which stated that "no person should be exposed to noise levels which endanger health and quality of life" (EC, 1993). This was followed by a Green Paper on future noise policy (EC, 1996), which reinforced the importance of noise as one of the main environmental problems in Europe and proposed a new framework for noise policy development.

The Sixth Environment Action Programme had as one of its objectives: "to achieve a quality of environment where the levels of man-made contaminants do not give rise to significant impacts on, or risks to, human health" (EC, 2002b). This paved the way for the Commission to adopt and implement the END in 2002 (EC, 2002a). The main aim of the Directive is "to define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure to environmental noise".

The END obliges the EC to adapt its Annexes I–III (I on noise indicators in addition to L_{den}[4] and L_{night}[5], II on noise assessment methods and III on methods for assessing harmful effects of noise) to technical and scientific progress. While work on revising Annex II was finalized in 2015 and common noise assessment methods were introduced (EC, 2015), revisions of Annex III to establish methods to assess the harmful effects of noise only started in 2015. Annex III would primarily define what exposure–response relationships should be used to assess the effect of noise on populations. EU Member States have already expressed the view that the recommendations from these environmental noise guidelines for the WHO European Region will guide the revision of Annex III. Beside this main directive, few other legislative documents cover different noise sources and other related issues in the EU (EEA, 2014: Annex I).

The Seventh Environment Action Programme, which guides European environment policy until 2020 (EC, 2014a), is committed to safeguarding the EU's citizens from environment-related risks to health by ensuring that by 2020 "noise pollution in the Union has significantly decreased, moving closer to WHO-recommended levels". A particular requirement for achieving this is "implementing an updated EU noise policy aligned with the latest scientific knowledge, and measures to reduce noise at source, and including improvements in city design".

In addition to the EU's END, several national governments also have legislation and/or limit values that apply at national and/or regional levels (WHO Regional Office for Europe, 2012). The EEA, through its European Topic Centre on Land Use and Spatial Information, gathers noise exposure data and maintains the Noise Observation and Information Service for Europe, based on strategic noise maps provided by Member States (EEA, 2018). A total of 33 EEA countries, in addition to six cooperating countries in south-eastern Europe, report information on noise exposure to the EEA, following the requirements of the END. The quality and availability of noise exposure assessment differs between EU and non-EU Member States where, even if noise legislation has been harmonized with the Directive, noise mapping and action plans are still at the planning stage (EEA, 2014; 2017a; WHO Regional Office for Europe, 2012).

1.2.1 Definition of indicators in the END

The END specifies a number of noise indicators to be applied by Member States in noise mapping and action planning. The most important are L_{den} and L_{night}.

The L_{den} indicator is an average sound pressure level over all days, evenings and nights in a year (EEA, 2010). This compound indicator was adopted by the EU in the END (EC, 2002a). The L_{den} in decibels (dB) is defined by a specific formula, where:

- L_{day} is the A-weighted long-term average sound level as defined in ISO 1996-1: 2016, determined over all the day periods of a year;
- $L_{evening}$ is the A-weighted long-term average sound level as defined in ISO 1996-1: 2016, determined over all the evening periods of a year; and
- L_{night} is the A-weighted long-term average sound level as defined in ISO 1996-1: 2016, determined over all the night periods of a year (ISO, 2016).

[4] Day-evening-night-weighted sound pressure level as defined in section 3.6.4 of ISO 1996-1:20161 (ISO, 2016).
[5] Equivalent continuous sound pressure level when the reference time interval is the night.

The L_{night}, according to the definition in the END, is an equivalent outdoor sound pressure level, measured at the most exposed façade, associated with a particular type of noise source during night time (at least eight hours), calculated over a period of a year (WHO Regional Office for Europe, 2009).

Annex I of the END gives technical definitions for L_{den} and L_{night}, as well as supplementary noise indicators, which might be useful for monitoring special noise situations. For example, in the case of noisy but short-lived noise like shooting noise or noise emitted by trains, $L_{A,max}$ is often used. This is a measure of the maximum sound pressure reached during a defined measurement period. It is used to set noise limits and is sometimes considered in studies to determine certain health effects (such as awakening reactions).

1.3 Perceptions of environmental noise in the WHO European Region

1.3.1 Trends at the regional level

The general population greatly values the benefits of clean and quiet environments. In Europe, people perceive noise as an important issue that affects human health and well-being (EC, 2008; 2014b). In recent years, several Europe-wide surveys have examined the perception of noise as an issue among the population. Overall, these surveys ask about generic noise, referring to "neighbourhood noise" or "noise from the street". This type of noise differs significantly in its definition from what is considered "environmental noise" in these guidelines. Nevertheless, in the absence of specific large surveys on perceptions of environmental noise as defined in these guidelines, the results provide insight into the public perception of this issue.

The European quality-of-life surveys, carried out every four years, are unique, pan-European surveys examining both the objective circumstances of lives of European citizens and how they feel about those circumstances and their lives in general. The last (fourth) survey was conducted in 2016–2017, involving nearly 37 000 citizens from all EU Member States and the five candidate countries (Albania, Montenegro, Serbia, the former Yugoslav Republic of Macedonia and Turkey). Respondents were asked whether they had major, moderate or no problems with noise in the immediate neighbourhood of their home. Almost one third (32%) reported problems with noise (ranging from 14% to 51% in individual countries), mainly in cities or city suburbs (49%) (Eurofound, 2017).

A 2010 survey of the then 27 countries in the EU, requested by the EC, showed that 80% of respondents (n = 26 602) believed that noise affects their health, either to some or to a great extent (EC, 2010).

A Eurobarometer report on attitudes of European citizens towards the environment (EC, 2014b) compiled opinions on various environmental risks from almost 28 000 respondents in 28 EU countries. Results showed that for 15% of respondents, noise pollution is one of the top five environmental issues they are worried about. Furthermore, 17% of respondents said that they lack information about noise pollution.

1.3.2 Trends at the national level

Data on perception of specific sources of environmental noise as a problem are not available for the entire WHO European Region. Nevertheless, some countries – including France, Germany, the Netherlands, Slovakia and the United Kingdom – conduct national surveys on noise annoyance, either regularly or on demand (Sobotova et al., 2006; Lambert & Philipps-Bertin, 2008; van Poll et al., 2011; Centraal Bureau voor de Statistiek, 2012; Notley et al., 2014; Umweltbundesamt, 2017).

According to these large-scale surveys, road traffic noise is the most important source of annoyance, generally followed closely by neighbour noise. Aircraft noise can also be a substantial source of annoyance. Railway noise and industrial noise are enumerated less frequently. Only limited data are available on the population's perception of newer sources of noise, such as wind turbines.

While perception surveys do not provide information on actual quantitative relationships between noise exposure and health outcomes, it is important to note that the results of such surveys represent people's preferences and values regarding environmental noise. Despite limitations and an incomplete picture, the available data on perception of environmental noise as a public health problem show concern in Europe. People are not always aware of the health impacts of noise, especially of those related to long-term noise exposure at lower levels. Greater awareness of the issue may further increase positive values and preferences.

1.4 Target audience

The environmental noise guidelines for the European Region serve as a reference for an audience made up of different groups, with varied areas of expertise including decision-making, research and advocacy. More specifically, this covers:

- various technical experts and decision-makers at the local, national or international levels, with responsibility for developing and implementing regulations and standards for noise control, urban planning and housing, and other relevant environment and health domains;
- health impact assessment and environmental impact assessment practitioners and researchers;
- national and local authorities responsible for developing and implementing relevant measures and for risk communication;
- nongovernmental organizations and other advocacy groups involved in risk communication and general awareness-raising.

These guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience, as a large body of the evidence underpinning the recommendations was derived not only from European noise effect studies but also from research in other parts of the world – mainly in America, Asia and Australia.

2. Development of the guidelines

2.1 Overview

The process of developing WHO guidelines follows a rigorous methodology and involves several groups with well defined roles and responsibilities (WHO, 2014c). These include: formulation of the scope and key questions of the guidelines; review of the pertinent literature; selection of priority health outcome measures; a systematic review of the evidence; an assessment of certainty of the bodies of evidence resulting from systematic reviews; identification of guideline exposure levels; and setting of the strength of recommendations. Throughout the process, the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was followed (Morgan et al., 2016).

The development of environmental noise guidelines started in 2013. Following WHO's procedures, the WHO Regional Office for Europe, through its European Centre for Environment and Health in Bonn, Germany, obtained planning approval and established a Steering Group and a Guideline Development Group (GDG). The former was primarily involved in initiating, structuring and executing the guideline development process; the latter was composed of leading experts and end-users, responsible for the process of scoping the guidelines and developing the evidence-based recommendations. During the initiation meeting in October 2013 in Bonn, the GDG members defined the scope of the guidelines, decided on the key questions to be addressed, prioritized health outcomes and set a timeline for completion of the work. Furthermore, authors were appointed for background papers, systematic reviews and different guideline background chapters.

In October 2014 a main evidence review meeting was held between the GDG and the Systematic Review Team in Bern, Switzerland, to discuss the evidence review drafts. In October 2014 and May 2015 the GDG met in Bern and Bonn, respectively, to refine the scope and draft recommendations. The revision and finalization of the systematic reviews of evidence was completed in early 2017. Through a series of remote meetings and teleconferences, the GDG discussed and addressed the remaining outstanding issues and feedback from the peer review of the draft guidelines, and decided on the final formulation of the recommendations. The following sections describe the steps of the guideline development process in detail.

2.2 Scope of the guidelines

Defining the scope of the guidelines included the selection of noise sources to be considered, as well as situations in which people are exposed, and noise indicators used for the formulation of recommendations. These guidelines separately consider outdoor exposure to environmental noise from road traffic, railway traffic, aircraft, wind turbines as well as outdoor and indoor exposure during leisure activities (such as attending nightclubs, pubs, fitness classes, live sporting events, concerts or live music venues and listening to loud music through personal listening devices). The guidelines are source specific and not environment specific. They therefore cover all settings where people spend a significant portion of their time, such as residences, educational institutions, workplaces and public venues, although hospital noise is exempted from the list of public institutions owing to the unique characteristics of the population involved.

The GDG agreed not to develop specific recommendations for occupational and industrial noise. Industrial noise can affect both people working at an industrial site and those living in its vicinity. The guidelines do not consider workers' exposure to noise in industrial environments, as these are regulated by workplace standards and may, in some cases, require the wearing of protective equipment or application of other preventive and protective measures. Further, the guidelines do not explicitly consider industrial noise as an environmental noise source, affecting people living in the vicinities of industrial sites. This is mainly due to the large heterogeneity and specific features of industrial noise, and the fact that exposure to industrial noise has a very localized character in the urban population.

Likewise, the current guidelines do not provide specific recommendations for the prevention of health effects linked to neighbourhood noise. Neighbourhood noise may stem from various potential sources of noise (such as ventilation systems; church bells; animals; neighbours; commercial, recreational and occupational activities; or shooting/military). As the sources may be located in close proximity to where people live, they can cause considerable concern even at low levels (Omlin et al., 2011). Several of these sources can also produce low-frequency noise, and as such, require indoor measurements for proper exposure assessment. In general, little scientific research is available on exposure and health outcomes related to neighbourhood noise.

Moreover, the guidelines do not include recommendations about any kind of multiple exposures. In everyday life people are often exposed to noise from several sources at the same time. In Germany, for example, 44% of the population are annoyed by at least two and up to five sources of noise (Umweltbundesamt, 2015). For some health outcomes, such as obesity, new evidence indicates that combined exposure to noise from several means of transportation is particularly harmful (Pyko et al., 2015; 2017).

Research indicates that, alongside exposure to more than one source of noise, combined exposure to different factors – for example, noise and vibration or noise and air pollution – has gained increasing relevance in recent years (Sörensen et al., 2017). The EC estimates that the social cost of noise and air pollution is up to €1 trillion every year (EC, 2016a). WHO acknowledges the need to develop comprehensive models to quantify the effects of multiple exposures on human health. As the main body of evidence on environmental noise still focuses on source-specific impacts of noise on health outcomes and does not incorporate combined exposure effects of multiple noise sources or other pollutants, however, the current guidelines provide recommendations for each source of noise specifically. No attempt has been made to combine noise from multiple sources for any particular health outcome.

2.2.1 Key questions

The environmental noise guidelines for the WHO European Region seek to address two main questions, which define the issues addressed by the guideline recommendations.

- In the general population exposed to environmental noise, what is the exposure–response relationship between exposure to environmental noise (reported as various indicators) and the proportion of people with a validated measure of health outcome, when adjusted for confounders?
- In the general population exposed to environmental noise, are interventions effective in reducing exposure to and/or health outcomes from environmental noise?

2.2.2 Environmental noise indicators used in the guidelines

From a scientific point of view, the best noise indicator is the one that performs best in predicting the effect of interest. There are, however, a number of additional criteria that may influence the choice of indicator because, for example, various indicators might be suitable for different health end-points and some indicators are more practical to use or easier to calculate than others. Some of these considerations are of a more political nature, as mentioned in the EC's Position paper on EU noise indicators (EC, 2000).

The current guidelines are intended to be suitable for policy-making primarily in the WHO European Region. They are therefore based on the most frequently used average noise indicators in Europe: L_{den} and L_{night}. These are often reported by authorities and are used widely for exposure assessment in health effect studies and noise impact assessments in the Region. The L_{den} (also referred to as "DENL") indicator can be calculated as the A-weighted average sound pressure level, measured over a 24-hour period, with a 10 dB penalty added to the average level in the night (23:00–07:00 or 22:00–06:00), a 5 dB penalty added to the evening (19:00–23:00 or 18:00–22:00) and no penalty added to the daytime period (07:00–19:00 or 06:00–18:00). The penalties are introduced to indicate people's extra sensitivity to noise during the evening and night. The L_{night} indicator is the A-weighted average sound pressure level, measured over an eight-hour period during night time, usually between 23:00 and 07:00 (EC, 2002a).

In these guidelines, L_{den} and L_{night} refer to a measurement or calculation of noise exposure at the most exposed façade, outdoors, reflecting the long-term average exposure. Thus, L_{den} and L_{night} represent all the single noise events due to a specific noise source that occur over a longer period of time, such as during a year. Moreover, most health outcomes considered in these guidelines are expected to occur as a result of long-term exposure. It is generally accepted that the most relevant parts of the whole day or night, which especially account for the time when a person is at home, are correctly attributed when using average indicators like L_{den} or L_{night}.

The majority of studies that form the body of evidence for the recommendations in these guidelines – among them large-scale epidemiological studies and socioacoustic surveys on annoyance and self-reported sleep disturbance – refer to noise exposure measured outdoors, usually at the most exposed façade of dwellings. Virtually all noise exposure prediction models in use today estimate free-field exposure levels outdoors, and most noise abatement regulations refer to outdoor levels as well. These are the practical reasons why the GDG decided not to recommend any guideline values for noise indoors. Nevertheless, in certain cases it could be helpful to estimate indoor levels based on outdoor values. The differences between indoor and outdoor levels are usually estimated at around 10 dB for open, 15 dB for tilted or half-open and about 25 dB for closed windows. When considering more accurate estimation of indoor levels, using a range of different predictors, the relevant scientific literature can be consulted (Locher et al., 2018).

The GDG was aware of the fact that many countries outside the EU are not bound by the terms of the END (EC, 2002a) and/or use noise indicators other than L_{den} or L_{night} in their noise regulations. They still can make use of these guidelines, however, because energy-based average noise indicators are usually highly correlated and "rule of thumb" transformations from one indicator to another are possible with acceptable uncertainty, as long as the conversion accounts for the long-term average

of populations, rather than individual exposure situations. Empirically derived generic conversion terms between a wide range of different noise indicators (including L_{den}, L_{dn}, L_{day}, L_{night} and $L_{Aeq,24h}$; see the glossary of acoustic terms for further details), with their uncertainty estimates, were published recently (Brink et al., 2018). The GDG encourages the use of these conversions, should the need arise.

In many situations, average noise levels like the L_{den} or L_{night} indicators may not be the best to explain a particular noise effect. Single-event noise indicators – such as the maximum sound pressure level ($L_{A,max}$)[6] and its frequency distribution – are warranted in specific situations, such as in the context of night-time railway or aircraft noise events that can clearly elicit awakenings and other physiological reactions that are mostly determined by $L_{A,max}$. Nevertheless, the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The guidelines therefore make no recommendations for single-event noise indicators.

Different noise sources – for example, road traffic noise and railway noise – can be characterized by different spectra, different noise level rise times of noise events, different temporal distributions of noise events and different frequency distributions of maximum levels. Because of the extensive differences in the characteristics of individual noise sources, these guidelines only consider source-specific exposure–response functions (ERFs) and, therefore, formulate only source-specific recommendations.

2.3 Evidence base

Based on the overall scope and key questions the current guidelines review the relevant literature in the area of environmental noise and health in order to incorporate significant research undertaken since the publication of previous guidelines. The process of evidence search and retrieval involved several steps. These include the identification, retrieval and synthesis of the evidence, followed by a systematic review and assessment (described in section 2.4).

2.3.1 Identification, retrieval and synthesis of evidence

As a first step, the GDG identified key health outcomes associated with environmental noise. Next, it rated the relevance of these health outcomes according to the following three categories:

- critical for assessing environmental noise issues
- important, but not critical for assessing environmental noise issues
- unimportant.

The GDG rated the relevance based on the seriousness and prevalence of the outcomes and the anticipated availability of evidence for an association with noise exposure. The following health outcomes were selected as either critical or important for developing recommendations on the health impacts of environmental noise.

[6] $L_{A,max}$ is the maximum time-weighted and A-weighted sound pressure level within a stated time interval starting at t1 and ending at t2, expressed in dB.

Critical health outcome	Important health outcome
Cardiovascular disease	Adverse birth outcomes
Annoyance[7]	Quality of life, well-being and mental health
Effects on sleep	Metabolic outcomes
Cognitive impairment	
Hearing impairment and tinnitus	

The GDG noted that research into the relationship between noise exposure and its effects on humans brings into focus several questions concerning the definition of health and the boundary between normal social reaction to noise and noise-induced ill health. As stated in WHO's Constitution: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). Accordingly, documenting physical health does not present a complete picture of general health; and being undisturbed by noise in all activities, including sleep, constitutes an asset worthy of protection. Therefore, in accordance with the above definition, the GDG regarded (long-term) annoyance and impaired well-being, as well as self-reported sleep disturbance due to noise, as health outcomes.

Regarding sleep disturbance, the health outcome measures considered in these guidelines largely disregard "objective" indicators of sleep disturbance, such as the probability of awakening reactions or other polysomnography parameters. The main reason for this is the nature of the body of evidence on acute, objectively measured effects of noise during sleep. Studies of physiological effects of sleep and especially polysomnographic investigations are complex and resource-demanding; they therefore include only a small number of participants, who are often healthy young volunteers not representative of the general population. For these reasons, the majority of such studies do not meet the requirements for inclusion in the GRADE framework and full-scale meta-analysis, including adjustment for confounders. Furthermore, it is currently unclear how acute physiological reactions that affect the microstructure of sleep but are less well correlated with global sleep parameters, such as total sleep time, are related to long-term health impediments, especially considering the large interindividual differences in susceptibility to noise (Basner et al., 2011).

As sleeping satisfies a basic need and the absence of undisturbed sleep can have serious effects on human health (WHO Regional Office for Europe, 2009), the GDG set self-reported sleep disturbance, in line with the WHO definition of health, as a primary health outcome. Even though self-reported sleep disturbance might differ considerably from objectively measured parameters of sleep physiology, it constitutes a valid indicator in its own right, as it reflects the effects on sleep perceived by an individual over a longer period of time (WHO Regional Office for Europe & JRC, 2011). The importance of considering both annoyance and self-reported sleep disturbance as health outcomes is further supported by evidence indicating that they may be part of the causal pathway of noise-induced cardiovascular and metabolic diseases. This is further elaborated in the narrative review on biological mechanisms (Eriksson et al., 2018).

[7] Noise annoyance is defined as a feeling of displeasure, nuisance, disturbance or irritation caused by a specific sound (Ouis, 2001). In the current guidelines, "annoyance" refers to long-term noise annoyance.

The second step in the evidence retrieval process constituted formulation of the key questions for the critical and important health outcomes and identification of the areas of evidence to be reviewed, following the PICOS/PECCOS approach defined in the WHO handbook for guideline development (WHO, 2014c). PICOS/PECCOS is an evidence-based technique that frames health care-related questions to facilitate the search for suitable studies that can provide answers to the questions at hand (Huang et al., 2006). The PICOS approach divides intervention questions into five elements: population, intervention, comparator, outcome and study design. In exposure studies, PICOS becomes PECCOS, which stands for population, exposure, comparator, confounder, outcome and study design. The specification of the elements of PICOS/PECCOS serves to construct the body of evidence that underpins each recommendation. Due to the complex nature of environmental noise, several distinct areas of evidence were defined to address each of the scoping questions comprehensively.

For each of the critical and important health outcomes a systematic review was conducted (see also section 2.3.2). Health outcomes regarded as important were given less weight in the decision-making process than critical ones. Inclusion and exclusion criteria to be regarded in the systematic evidence reviews were defined in accordance with the PICOS/PECCOS framework for the evaluation of evidence (see Table 1). All evidence that met the inclusion criteria was included in the systematic reviewing process. A detailed description of the types of measure for each of the health outcomes under consideration is provided in the protocol for conducting the systematic reviews (Héroux & Verbeek, 2018a). See Annex 2 for details of all background documents and systematic reviews used in preparation of these guidelines.

Table 1. Inclusion and exclusion criteria for evidence reviews of health effects of environmental noise

Category	Inclusion criteria	Exclusion criteria
Populations	• Members of the general population • Specific segments of the population particularly at risk (children or vulnerable groups) • People exposed to noise in occupational settings (if relevant with combined exposure to environmental noise)	• Does not meet inclusion criteria
Exposure	• Noise exposure levels, either measured or calculated and expressed in dB values • Representative of the individual exposure of study participants (for most observational studies the dwelling location or home) • Calculated levels for transportation noise (road, rail, air) based on traffic data reflecting the use of roads, railway lines and in- and outbound flight routes at airports	• Does not meet inclusion criteria; in particular: - studies using hearing loss or hearing impairment as a proxy for (previous) noise exposure - surveys assessing noise exposure or number of listening hours based on subjective ratings given by subjects in a questionnaire
Confounders	• No inclusion criteria applied since the relationship between exposure to noise and a health outcome can be confounded by other risk factors; however, possible confounders taken into account were assessed for every study	• No exclusion criteria applied; however, possible confounders taken into account were assessed for every study

Table 1. contd.

Category	Inclusion criteria	Exclusion criteria
Outcomes	• Adverse birth outcomes • Annoyance • Cardiovascular disease • Cognitive impairment • Effects on sleep • Hearing impairment and tinnitus • Metabolic outcomes • Quality of life, mental health and well-being	• Does not meet inclusion criteria
Study types	• Cohort studies • Case-control studies • Cross-sectional studies • Ecological studies (only for cardiovascular disease)	• Does not meet inclusion criteria

Alongside the systematic reviews of the critical and important health outcomes, the GDG decided to review the evidence on health effects from noise mitigation measures and interventions to reduce noise levels in order to inform and complement the recommendations.

Interventions on environmental noise were defined according to five broad categories based on the available intervention literature and the experience of decades of environmental noise management (see Table 2 and Brown & van Kamp, 2017).

Table 2. Types of noise intervention

Intervention type	Intervention category	Intervention subcategory
A	Source intervention	• change in emission levels of sources • time restrictions on source operations
B	Path intervention	• change in the path between source and receiver • path control through insulation of receiver/receiver's dwelling
C	New/closed infrastructure	• opening of a new infrastructure noise source • closure of an existing one • planning controls between (new) receivers and sources
D	Other physical intervention	• change in other physical dimensions of dwelling/neighbourhood
E	Behaviour change intervention	• change in individual behaviour to reduce exposure • avoidance or duration of exposure • community education, communication

The GDG recognized that nonacoustic factors are an important possible confounder in both ERFs between noise levels and critical health effects and the effects of acoustic interventions on health outcomes. Whereas the inclusion criteria for confounders were not specified in PECCOS for the systematic reviews of evidence, they were considered at the stage of assessing the quality of

evidence, using the GRADE approach. Depending on the health effect under investigation, possible nonacoustic factors may include:

- gender
- age
- education
- subjective noise sensitivity
- extroversion/introversion
- general stress score
- co-morbidity
- length of residence
- duration of stay at dwelling in the day
- window orientation of a bedroom or living room towards the street
- personal evaluation of the source
- attitudes towards the noise source
- coping capacity with respect to noise
- perception of malfeasance by the authorities responsible
- body mass index
- smoking habits.

In noise annoyance studies nonacoustic factors may explain up to 33% of the variance (Guski, 1999). The higher the quality of evidence, the lower confounding effects of nonacoustic factors may be expected. Nevertheless, as with measurement errors, confounding cannot be avoided.

Based on the retrieval and evaluation of the pertinent literature, the GDG decided to address the association of environmental noise from different sources and health outcomes separately and individually for each source of noise, and for critical and important health outcomes.

In addition to the systematic reviews of the health effects of environmental noise, a narrative review of biological mechanisms of nonauditory effects was conducted (Eriksson et al., 2018). This covers literature related to pathways for nonauditory effects and provides supporting evidence on the association between environmental noise and health outcomes in humans, especially related to cardiovascular and metabolic diseases.

2.3.2 Systematic reviewing process

After the retrieval of the evidence based on the PICOS/PECCOS approach, systematic reviews were conducted for all critical and important health outcomes. To meet the demands of the diverse and broad nature of the evidence, it was agreed that systematic reviews could vary in type. For some areas of evidence, a novel and fully fledged systematic reviewing process was needed to summarize the existing evidence; for others, the reviewing process could build upon existing (and mostly published) systematic reviews and summaries of evidence. Thus, the process consisted of two phases.

First, a comprehensive search was conducted for available systematic reviews and meta-analyses on environmental noise effects published after 2000. Each of the reviews was assessed for both relevance and quality. To be included in the evidence review process, studies from these reviews were required to meet a high quality standard, judged according to high scores of the AMSTAR checklist.[8] In cases where quality criteria were met but the review was older than two years (published before 2012), the search of the systematic review was updated to include new papers. If no good quality systematic reviews were available, a new search for original papers was conducted. The Systematic Review Team decided how the results would affect the search strategy for individual studies as part of the second phase. This was based on the assessment of the quality of the systematic reviews and on the coherence between the main research questions of the systematic reviews and the scope of the work of the guidelines.

In the second phase a search for individual papers was conducted, with the search strategy adapted according to the outcome of the first phase. As availability of systematic reviews and meta-analyses differed for the various health outcomes considered in the guidelines, this process varied for each evidence review. The search included cohort studies, case-control studies and cross-sectional studies of people exposed to environmental noise. Where relevant – for example, for the health outcome cardiovascular disease – the search also included ecological studies.

Due to the individualized retrieval of evidence for each of the systematic reviews, the time frames of the literature included varied. An indication of the temporal coverage of the studies included in different systematic review is provided in the relevant tables in Chapter 4.

A detailed description of the methodology used to conduct the systematic evidence reviews, including individual protocols for the reviews of health effects resulting from environmental noise and from noise interventions, is available (Héroux & Verbeek, 2018b). Furthermore, all systematic reviews conducted in the guideline development process are publicly available in the open-access journal *International Journal of Environmental Research and Public Health*:

- systematic review of transport noise interventions and their impacts on health (Brown & van Kamp, 2017);
- systematic review on environmental noise and adverse birth outcomes (Nieuwenhuijsen et al, 2017);
- systematic review on environmental noise and annoyance (Guski et al., 2017);
- systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018);
- systematic review on environmental noise and cognition (Clark & Paunovic, 2018);
- systematic review on environmental noise and effects on sleep (Basner & McGuire, 2018);
- systematic review on environmental noise and permanent hearing loss and tinnitus (Śliwińska-Kowalska & Zaborowski, 2017);
- systematic review on mental health and well-being (Clark & Paunovic, in press).

[8] AMSTAR is an instrument used to assess quality of evidence; it stands for “A MeaSurement Tool to Assess systematic Reviews” (Shea et al., 2007).

2.4 From evidence to recommendations

Once the evidence had been identified and synthesized, the Systematic Review Team assessed its quality. Subsequently, the GDG formulated recommendations, guided by this assessment and consideration of a number of other factors recognized as important. To facilitate the formulation of recommendations, it first prioritized the health outcome measures of the critical and important outcomes. A process was developed to identify the guideline exposure levels from each of the ERFs provided by the systematic reviews of evidence.

The following sections describe the assessment of the overall quality of the evidence based on the GRADE approach, selection of priority health outcome measurements, identification of guideline exposure levels and setting the strength of recommendations.

2.4.1 Assessment of overall quality of a body of evidence: the GRADE approach

As set out in the WHO handbook for guideline development (WHO, 2014c), the main framework for producing evidence-informed recommendations is the GRADE approach (Guyatt et al., 2008). This is used to assess the quality of a body of evidence synthesized in a systematic review. The assessment facilitates judgements about the certainty of effect estimates, which increases with the quality of the body of evidence. The quality can be rated high, moderate, low or very low (see Box 1).

Box 1 GRADE interpretations of quality of evidence

- **High quality:** further research is very unlikely to change the certainty of the effect estimate
- **Moderate quality:** further research is likely to have an important impact on the certainty of the effect estimate and may change the estimate
- **Low quality:** further research is very likely to have an important impact on the certainty of the effect estimate and is likely to change the estimate
- **Very low quality:** any effect estimate is uncertain

The original GRADE approach was developed specifically to rate the body of evidence resulting from a review of intervention studies. The initial quality level is set by study design: randomized control trials (RCTs) are considered high quality, whereas observational (nonrandomized) study designs are low quality. Then five factors are considered for downgrading the quality of the body of evidence resulting from RCTs or observational studies, and three factors are considered for upgrading the body of evidence resulting from observational studies alone.

The following five factors are used for downgrading the quality of evidence by one or two levels:

- study limitations or risk of bias in all studies that make up the body of evidence
- inconsistency of results between studies
- indirectness of evidence in the studies
- imprecision of the pooled effect estimate
- publication bias detected in a body of evidence.

The following three factors are used for upgrading the quality of evidence:

- high magnitude of the pooled effect
- direction of residual confounding and biases opposes an effect (i.e. when all plausible confounders are anticipated to reduce the estimated effect and there is still a significant effect)
- exposure–response gradient.

The GRADE approach was originally developed for application in the field of clinical medicine, where the majority of studies are randomized trials. However, to assess health effects resulting from an exposure such as environmental noise, randomized controlled trials are not applicable, as it would be unethical to expose participants deliberately to possibly harmful risk factors. The limitations of the application of GRADE to environmental health have been recognized and discussed in the literature (Morgan et al., 2016). Other types of study design dominate the evidence base in the domain of environmental noise research, so it was necessary to adapt the original GRADE approach to the subject of the current guidelines, as follows.

Instead of using the RCT study design as the starting-point for the quality rating, the study design most applicable and available for the field of research at hand was used. Thus, for evidence on the association between noise exposure and clinical health outcome measures, the rating of an evidence base consisting of cohort and case-control studies[9] was initially rated high quality. Cross-sectional studies and ecological studies were rated low quality and very low quality, respectively. This initial point of departure was only adapted for the evidence of the association between noise exposure and annoyance and sleep disturbance. Here, cross-sectional studies were rated high quality because annoyance and sleep disturbance are regarded as an immediate effect of exposure to environmental noise. Finally, in accordance with the original GRADE approach, the starting-point for evidence on the effect of interventions was rated low quality for observational studies. After determining the point of departure, the evidence base was rated down or up whenever one or more of the criteria for downgrading or upgrading (described above) were met. Each of the systematic reviews commissioned for these guidelines includes a detailed report on the assessment of the quality of the evidence.

A detailed discussion of the adaptations of GRADE is provided in the separate methodology publication (Héroux & Verbeek, 2018b).

2.4.2 Selection of priority health outcomes

In line with the WHO handbook for guideline development (WHO, 2014c), the GDG selected the key health outcomes associated with environmental noise at the beginning of the evidence retrieval process, and the systematic reviews were commissioned accordingly. The selection of health outcomes was based on the available evidence for the association between environmental noise and the specific outcome, as well as public concern about the health outcome resulting from noise exposure. The following health outcomes were rated critical: cardiovascular disease, annoyance,

[9] In the context of the current guidelines, “cohort studies” refer to longitudinal studies in which the occurrence of the outcome of interest in an exposed group is compared to the occurrence of that outcome in a reference group with no or lower exposure over time.

effects on sleep, cognitive impairment and hearing impairment and tinnitus. Adverse birth outcomes, quality of life, well-being and mental health, and metabolic outcomes were rated important (see also section 2.3.1).

Since all these health outcomes can be measured in various ways, the GDG evaluated each individually and prioritized different outcome measures for each in terms of their representativeness and validity. These measures were used to derive the guideline exposure levels; their prioritization was based on the impact of the disease and the disability weights (DWs) associated with the health outcome measure.[10]

The critical health outcomes, priority outcome measures identified and justifications for their selection are listed in Table 3.

Table 3. Critical health outcomes, outcome measures identified and justifications for selection

Critical health outcome	Critical health outcome measures (priority measures marked in bold)	Justification for selection
Cardiovascular disease (L_{den})	Self-reported or measured prevalence, **incidence**, hospital admission or mortality due to: • **ischaemic heart disease (IHD) (including angina pectoris and/or myocardial infarction)** • **hypertension** • stroke	Except for self-reports, these are objective measures of the outcome, affect a large proportion of the population, have important health consequences and can lead to more severe diseases and/or mortality. DW for IHD: 0.405. DW for hypertension: 0.117.
Effects on sleep (L_{night})	• **percentage of the population highly sleep-disturbed (%HSD)**, self-reported, assessed with a standardized scale • polysomnography measured outcomes (probability of additional awakenings) • cardiac and blood pressure outcome measures during sleep • motility measured sleep outcomes in adults • sleep disturbance in children	This is the most meaningful, policy-relevant measure of this health outcome. Self-reported sleep disturbances are a very common problem in the general population: they affect quality of life directly and may also lead to subsequent health impediments. Effects on sleep may be in the causal pathway to cardiovascular disease. This measure is not a proxy for physiological sleep quality parameters but is an important outcome in its own right. DW for %HSD: 0.07.
Annoyance (L_{den})	• **percentage of the population highly annoyed (%HA), assessed with standardized scale** • percentage annoyed, preferably assessed with standardized scale	This is the most objective measure of this health outcome. Large proportions of the population are affected by noise annoyance, even at relatively low exposure levels. Annoyance may be in the causal pathway to cardiovascular disease. DW for %HA: 0.02.

[10] DWs are ratings that vary between 0 and 1, in which 0 indicates no disability and 1 indicates the maximum amount of disability. The rates are derived from large population surveys in which people are asked to rank a specific disease for its impact on several abilities. The DWs have been proven useful in calculating the burden of disease.

Table 3. contd.

Critical health outcome	Critical health outcome measures (priority measures marked in bold)	Justification for selection
Cognitive impairment (L_{den})	• **reading and oral comprehension, assessed with tests** • impairment assessed with standardized tests • short and long-term memory deficit • attention deficit • executive function deficit (working memory capacity)	This outcome measure is the most meaningful: it can affect vulnerable individuals (children) and have a significant impact later in life. DW for impaired reading and oral comprehension: 0.006.
Hearing impairment and tinnitus (L_{Aeq}[11] and $L_{AF,max}$[12])	• **permanent hearing impairment, measured by audiometry** • permanent tinnitus	This outcome measure can affect vulnerable individuals (children) and have a significant impact later in life. It is the most objective measure for which there is an ISO standard (ISO, 2013), specifying how to estimate noise-induced hearing loss. DW for mild severity level (threshold at 25 dB) for childhood onset: 0.0150.

Table 4 provides a list of the important health outcomes along with the corresponding health outcome measures included in the systematic reviews. There was no prioritization of health outcome measures leading to justification of selection, since important health outcomes had less impact on the development of recommendations.

Table 4. Important health outcomes and health outcome measures reviewed

Important health outcome	Health outcome measures reviewed
Adverse birth outcomes (L_{den})	• pre-term delivery • low birth weight • congenital anomalies
Quality of life, well-being and mental health (L_{den})	• self-reported health and quality of life • medication intake for depression and anxiety • self-reported depression, anxiety and psychological distress • interviewer-assessed depressive and anxiety disorders • emotional and conduct disorders in children • children's hyperactivity • other mental health outcomes
Metabolic outcomes (L_{den})	prevalence, incidence, hospital admission or mortality due to: • type 2 diabetes • obesity

[11] L_{Aeq} is an A-weighted, equivalent continuous sound pressure level during a stated time interval starting at t1 and ending at t2, expressed in dB, of a noise at a given point in space.

[12] $L_{AF,max}$ is the maximum time-weighted and A-weighted sound pressure level with FAST time constant within a stated time interval starting at t1 and ending at t2, expressed in dB.

2.4.3 Identification of guideline exposure levels for each noise source

The GDG agreed to set guideline exposure levels based on the definition: "noise exposure levels above which the GDG is confident that there is an increased risk of adverse health effects". The identification of guideline values for each of the specific noise sources involved five distinct steps:

1. assessment of the validity of ERFs resulting from the systematic reviews of the effects of noise on each of the critical and important health outcomes;
2. assessment of the lowest noise level measured in the studies included in each of the corresponding systematic reviews;
3. assessment of the smallest risk or relative risk (RR) increase for each of the adverse health outcomes considered relevant;
4. determination of the guideline exposure level based on the ERF, starting from the lowest level measured (see step 2) and associated with the smallest relevant risk increase for adverse health outcomes (see step 3);
5. comparison of the guideline exposure levels calculated for each of the critical health outcomes of one source (for example, incidence of IHD, incidence of hypertension, %HA, permanent hearing impairment and reading and oral comprehension for road traffic noise): selection of the guideline exposure level for each noise source was based on the priority health outcome measure with the lowest exposure level for that source.

To define an "increased risk" to set the guideline exposure level, the GDG made a judgement about the smallest risk or RR of the adverse health effect it considered relevant for each of the priority health outcome measures. It is important to note that the relevant risk increases are benchmark values. The GDG agreed to set them in accordance with the guiding principles it had developed, to provide guideline values that illustrate an increased risk of adverse health effects. It used expert judgements for the determination of the benchmark values; these are elaborated further in section 2.4.3.2.

The guideline exposure levels presented are therefore not meant to identify effect thresholds (the lowest observed adverse effect levels for different health outcomes). This is a difference in approach from prior WHO guidelines, like the night noise guidelines for Europe (WHO Regional Office for Europe, 2009), which explicitly aimed to define levels indicating no adverse health effects. The approach to making choices about relevant risk increases is outlined below and summarized in Table 5.

For IHD and hypertension, RR increases were considered; for annoyance and sleep disturbance, absolute risks of %HA and %HSD were considered; and for reading and oral comprehension an average delay of reading age was defined. For the cardiovascular outcomes, incidence measures were prioritized, although much of the epidemiological evidence was based on prevalence data – particularly for hypertension – where almost no longitudinal studies were available. Prevalence data are generally derived from cross-sectional studies, where the temporal aspects are difficult to determine.

Table 5. Priority health outcomes and relevant risk increases for setting guideline levels

Priority health outcome measure (associated DW)	Relevant risk increase considered for setting of guideline level
Incidence of IHD (DW: 0.405)	5% RR increase
Incidence of hypertension (DW: 0.117)	10% RR increase
%HA (DW: 0.02)	10% absolute risk
%HSD (DW: 0.07)	3% absolute risk
Permanent hearing impairment (DW: 0.0150)	No risk increase due to environmental noise
Reading and oral comprehension (DW: 0.006)	One-month delay in terms of reading age

The DWs used to rank the priority critical health outcomes measures were retrieved from the relevant literature. For cardiovascular disease as a group and for hypertension, the burden of disease from environmental noise values (WHO Regional Office for Europe & JRC, 2011) were not considered applicable by the GDG for these guidelines. Thus, for cardiovascular disease, the DW value (DW: 0.405) specifically applied to acute myocardial infarction in the publication outlining the data sources, methods and results of the global burden of disease in 2002 (Mathers et al., 2003) was retained. Since hypertension is mainly viewed as an important risk factor and not as a health outcome, no general DW has been developed. The only other available DW value available is the DW of 0.117 for hypertensive episodes in pregnancy (Mathers et al., 1999). In the absence of any general DW, the GDG agreed on a conservative approach and decided to use this value.

The DWs for high sleep disturbance (DW: 0.07), high annoyance (DW: 0.02) and impaired reading and oral comprehension (DW: 0.006) were developed in the context of calculating the burden of disease from environmental noise (WHO Regional Office for Europe & JRC, 2011). The DW for hearing impairment was not included in that publication, but it was available from the technical paper on the burden of disease from environmental noise (WHO, 2013); the DW for permanent hearing impairment ranged from 0.0031 to 0.3342, depending on severity level. Environmental noise (leisure noise) contributes to the cumulative total noise exposure throughout the life-course, which may lead to permanent hearing impairment and cause more severe disability in the later years of life. As a result, the GDG selected a DW of 0.0150 for moderate severity level ("has difficulty following a conversation in a noisy environment, but no other hearing problems"). For cognitive impairment, the DW was derived from the estimates of the burden of disease from environmental noise (WHO Regional Office for Europe & JRC, 2011). This was at a very conservative value (DW: 0.006) for noise-related impairment of children's cognition, equivalent to a DW for contemporaneous cognitive deficit in the context of a range of cognitive impairments in children ranging from 0.468 for Japanese encephalitis to 0.024 for iron deficiency anaemia (Lopez et al., 2006).

2.4.3.1 Development of ERFs

The systematic reviews of evidence provided either an ERF or other noise exposure value/metric that could be related to a risk increase of the health outcome measure. These ERFs were used to develop guideline exposure levels; however, only those functions where noise exposure demonstrated a statistically significant effect were used.

To obtain the starting level of the ERFs derived in the systematic reviews, a weighted average of the lowest exposure values measured in the individual studies included in the meta-analyses was

calculated. The weighting used the inverse of the variance of the effect estimate of the study. Thus, the lowest exposure value of studies with a small variance (usually with the largest sample size) contributed the most to the assumed onset of the ERF.

2.4.3.2 Relevant risk increase of adverse health effects

The following sections describe in detail the rationale for the selection of the relevant relative risk (RR) increase percentage for each of the priority health outcome measures considered.

Cardiovascular disease: IHD and hypertension

High-quality epidemiological evidence described in the systematic review on cardiovascular and metabolic effects of environmental noise indicates that exposure to road traffic noise increases the risk of IHD (van Kempen et al., 2018). The GDG was confident that health risks result from exposure at an RR increase in the order of 5–10% in the incidence of IHD. This is similar to the reasoning in the WHO air quality guidelines for fine particulate matter ($PM_{2.5}$) (WHO, 2006). To determine a relevant risk increase for IHD, the GDG took as a starting-point the RR increase of 5% measured in epidemiological studies of environmental noise or air pollution. Taking into account the incidence of IHD and the seriousness of the disease, it considered lowering the RR increase for IHD to 1%, as a 5% RR increase might imply a comparatively high absolute risk from a population perspective. To decide on the final benchmark value for IHD, several aspects were considered: the number of people in a population affected by IHD; whether health risks caused by noise would make up a large part of the incidence of the disease; other examples of health risks of similar magnitude leading to preventive action. For IHD, in an average EU country with 20 million inhabitants, an RR increase of 5% for IHD would lead to several thousand extra cases attributable to noise yearly. This corresponds to a proportion of cases of IHD attributable to noise exposure of less than 10%, which is still relatively small. After extensive discussion at the very end of the guideline development process, the GDG decided to adhere to 5% as the relevant risk increase.

Hypertension is a common condition and is an important risk indicator for IHD and other cardiovascular diseases. Thus, the hypertension risk increase can be transformed into a risk increase for cardiovascular disease. To derive a relevant risk increase, the GDG focused on the incidence of hypertension, owing to the nature and quality of epidemiological evidence. Since hypertension is less serious than IHD, and not all people with hypertension will progress to cardiovascular disease, the relevant risk increase in the incidence of hypertension needed to be higher than that for IHD. Therefore, the GDG agreed on an RR increase of 10% for hypertension.

Self-reported sleep disturbance and annoyance

The GDG initially considered 5%HSD and 10%HA due to noise as relevant absolute risks, not be exceeded at the guideline level. After discussion, however, members agreed that these absolute risks were too large, since a considerable proportion of the population would still be affected; they decided to lower the relevant risk from 5% being highly sleep-disturbed to 3%. In doing so, the GDG referred to the WHO night noise guidelines (WHO, 2009), which concluded that while there was insufficient evidence that physiological effects at noise levels below 40 dB L_{night} are harmful to health, there were observed adverse health effects at levels starting from 40 dB L_{night}. At 40 dB, about 3–4%

(depending on the noise source) of the population still reported being highly sleep-disturbed due to noise, which was considered relevant to health. The GDG considered it important that this level is consistent with the previous health-based approach adopted by the WHO night noise guidelines, and agreed that the absolute risk associated with the guideline value selected should not exceed 3%HSD to be health protective.

For annoyance, which is considered a less serious health effect than self-reported sleep disturbance (as indicated by the respective DWs), the relevant risk remained at 10%HA. This means the absolute risk associated with the guideline value selected should be closest to, but not above 10%HA, to be health protective.

Cognitive impairment: reading and oral comprehension

Acquiring skills in reading and oral comprehension at a young age is important for further development: a delay in acquiring these skills can have an impact later in life (Wilson & Lonigan, 2010). This impact cannot be predicted very accurately, but the GDG considered a delay of one month a relevant absolute risk.

Permanent hearing impairment

The literature on hearing impairment as a result of occupational noise exposure is extensive. A noise exposure level beyond 80 dB during 40 years of working a 40 hour work week can give rise to permanent hearing impairment. Given that environmental exposure to noise is much lower than these levels and that noise-related hearing impairments are not reversible, the GDG considered that there should be no risk of hearing impairment due to environmental noise and considered any increased risk of hearing impairment relevant.

2.4.4 Strength of the recommendations

Finally, having determined the guideline exposure levels based on the ranking of prioritized health outcome measures, setting the strength of the recommendation was set as the final step of the guideline development process. This was also guided by the GRADE methodology (Alonso-Coello et al., 2016a; 2016b). According to this approach, strength of recommendation can be set as either strong or conditional (WHO, 2014c).

- A **strong** recommendation can be adopted as policy in most situations. The guideline is based on the confidence that the desirable effects of adherence to the recommendation outweigh the undesirable consequences. The quality of evidence for a net benefit – combined with information about the values, preferences and resources – inform this recommendation, which should be implemented in most circumstances.
- A **conditional** recommendation requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply.

The GRADE approach defines a number of parameters that should be assessed to determine the strength of recommendations: quality of evidence, balance of benefits and harms, values and preference related to the outcomes of interventions to exposure, resources implications, priority of the problem, equity and human rights, acceptability and feasibility (Box 2; Morgan et al., 2016).

Box 2 Parameters determining the strength of a recommendation

Quality of evidence further represents the confidence in the estimates of effect of the evaluated evidence, across outcomes critical and important to decision-making. The higher the quality of evidence, the greater the likelihood of a strong recommendation.

Balance of benefits and harms requires an evaluation of the absolute effects of both benefits and harms (or downsides) of the intervention or exposure and their importance. The greater net benefit or net harm associated with an intervention or an exposure, the greater the likelihood of a strong recommendation in favour or against an intervention or exposure.

Values and preferences related to the outcomes of an intervention or exposure set out the relative importance assigned to health outcomes by those affected by them; how such importance varies within and across populations; and whether this importance or variability is surrounded by uncertainty. The less uncertainty or variability there is about the values and preferences of people experiencing the critical or important outcomes, the greater the likelihood of a strong recommendation.

Resource implications take into consideration how resource-intensive and how cost-effective and substantially beneficial an intervention or exposure is. The more advantageous or clearly disadvantageous the resource implications are, the greater the likelihood of a strong recommendation either for or against the intervention or exposure.

The priority of the problem is determined by its importance and frequency (the burden of disease, disease prevalence or baseline risk). The greater the importance of the problem, the greater the likelihood of a strong recommendation.

Equity and human rights considerations are an important aspect of the process. The greater the likelihood that the intervention will reduce inequities, improve equity or contribute to the realization of one or several human rights as defined under the international legal framework, the greater the likelihood of a strong recommendation.

Acceptability plays a prominent role: the greater the acceptability of an option to all or most stakeholders, the greater the likelihood of a strong recommendation.

Feasibility overlaps with values and preferences, resource considerations, existing infrastructures, equity, cultural norms, legal frameworks and many other considerations. The greater the feasibility of an option from the standpoint of all or most stakeholders, the greater the likelihood of a strong recommendation.

The GDG evaluated the strength of the recommendations based on these parameters, following a two-step procedure. Initially, the strength of each recommendation was set as strong or conditional based on an assessment of the quality of evidence. The GDG then identified and assessed contextual

parameters that might have a contributory role (see Box 2 above). Based on this qualitative evaluation, the initial recommendation strength was either adapted or confirmed. It is important to note that while the initial parameter "quality of evidence" was informed by comprehensive systematic reviewing processes, the remaining contextual parameters were assessed by the informed qualitative expert judgement of the GDG.

Furthermore, the GDG agreed to decision-making rules, applied when formulating the recommendations. An evidence rating of low quality or very low quality would lead only to a conditional recommendation. Setting a strong recommendation was only considered if the evidence was at least moderate quality. The final recommendations were formulated based on the consideration of all the parameters and decision rules adopted by the GDG. A detailed exploration of all the recommendations is set out in Chapter 3.

2.5 Individuals and partners involved in the guideline development process

The process of WHO guideline development is conducted by several groups with clearly defined roles and responsibilities. Comprising WHO staff members, experts and stakeholders, these are the Steering Group, the GDG, the Systematic Review Team and the External Review Group.

The **Steering Group** includes WHO staff members with different affiliations but whose work experience is relevant to the topic of environmental noise and associated health outcomes. It is involved at all stages of planning, selecting members of the GDG and External Review Group, reviewing evidence and developing potential recommendations at the main expert meetings, as well as ongoing consultation on revisions following peer review. Details of the members of the Steering Group are listed in Table A1.1 in Annex 1.

The **GDG** consists of a group of content experts gathered to investigate all aspects of evidence contributing to the recommendations, including expertise in evidence-based guideline development. This Group defined the key questions and priorities of the research, chose and ranked outcomes and provided advice on any modifications of the scope as established by the Steering Group. The members also outlined the systematic review methods; appraised the evidence used to inform the guidelines; and advised on the interpretation of this evidence, with explicit consideration of the overall balance of benefits and harms. Ultimately the GDG formulated the final recommendations, taking into account the diverse values and preferences of individuals and populations affected. It also determined the strength of the results and responded to external peer reviews. The complete list of GDG members and their specific roles, affiliations and areas of expertise are listed in Table A1.2 in Annex 1.

The **Systematic Review Team** includes experts in the field of environmental health, commissioned by WHO staff to undertake systematic reviews of evidence. The GDG recommended a number of authors to conduct the evidence reviews and summary chapters, based on their expertise. Details of the members of the Systtematic Review Team are included in Table A1.3 in Annex 1.

The **External Review Group** is composed of technical content experts and end-users as well as stakeholders, and is balanced geographically and by gender. The experts and end-users were selected for their expertise in the field, and the Group also included representatives of professional groups and industry associations, who will be implementing the guidelines. Members were asked to

review the material at different stages of the development process. The list of technical experts and stakeholders is provided in Tables A1.4 and A1.5, respectively, in Annex 1.

Management of conflict of interest is an integral part of WHO's guideline development procedure. All members of the GDG and authors of the evidence reviews completed WHO declaration of interest forms. These were reviewed by the WHO Secretariat for potential conflicts of interest. A number of conflicts of interest were declared in the forms, but following a standardized management review it was not found necessary to exclude any members of the GDG or authors from their respective roles. Members of the External Review Group (technical experts only) were also asked to complete the form when invited to participate.

In addition, at the start of the meeting of the GDG all members of the GDG received a briefing about the nature of all types of conflict of interest (financial, academic/intellectual and nonacademic) and were asked to declare to the meeting any conflicts they might have. No member of the GDG or the Systematic Review Team was excluded from his/her respective role. A summary of the conflict of interest management is presented in Annex 3.

The GDG set its own rules on how it would work and how contentious issues should be resolved – for instance, by means of a vote. The main decision-making mechanism involved reaching consensus; if a vote was required, the experts involved in developing the underlying evidence for the specific recommendation were excluded from voting, and an agreement was reached via a two thirds majority of the rest of the group.

2.6 Previously published WHO guidelines on environmental noise

Prior to this publication, WHO published community noise guidelines (CNG) in 1999 (WHO, 1999) and night noise guidelines for Europe (NNG) in 2009 (WHO Regional Office for Europe, 2009).

2.6.1 CNG

The scope of WHO's efforts to develop the CNG in 1999 was similar to that for the current guidelines. The objective was then formulated as: "to consolidate scientific knowledge of the time on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in nonindustrial environments" (WHO, 1999). The guidelines were based on studies carried out up to 1995 and a few meta-analyses from some years later.

The health risk to humans from exposure to environmental noise was evaluated and guideline values derived. At that time WHO had not yet developed its guideline development process, on which the current guidelines are based (WHO, 2014c). The main differences in content are that the previous guidelines were expert-based and provided more global coverage and applicability, such as issues of noise assessment and control that were addressed in detail. They included a discussion on noise sources and measurement, including the basic aspects of source characteristics, sound propagation and transmission. Adverse health effects of noise were characterized, and combined noise sources and their effects were considered. Furthermore, the guidelines included discussions of strategies and priorities in the management of indoor noise levels, noise policies and legislation, environmental

noise impact and enforcement of regulatory standards; although there were no chapters on wind turbine noise and leisure noise.

2.6.2 NNG

In 2009 the WHO Regional Office for Europe published the NNG to provide scientifically based advice to Member States for the development of future legislation and policy action in the area of assessment and control of night noise exposure.

The NNG complement the previous CNG, incorporating the advancement of research on noise and sleep disturbance up to 2006. The working group of experts reviewed available scientific evidence on the health effects of night noise and derived health-based guideline values. Again, WHO had not yet introduced its evidence-based recommendations policy and the NNG were mainly expert-based. They considered the scientific evidence on the threshold of night noise exposure indicated by L_{night} as defined in the END (EC, 2002a), and the experts concluded that a L_{night} value of 40 dB should be the target of the NNG (for all sources) to protect the public, including the most vulnerable groups such as children, chronically ill and elderly people. Further, an L_{night} value of 55 dB was recommended as an interim target for countries that could not follow the guidelines in the short term for various reasons or where policy-makers chose to adopt a stepwise approach.

2.6.3 Differences from the prior noise guidelines

The current guidelines differ from the older ones, recommending levels of exposure unlike those previously outlined (especially by the NNG). The following major differences between the previous and current guidelines explain the novel set of recommended values.

- The development process for the current guidelines adhered to a new, rigorous, evidence-based methodology, as outlined in the WHO handbook for guideline development (WHO, 2014c). WHO adopted these internationally recognized standards to ensure high methodological quality and a transparent, evidence-based decision-making process in the guideline development.
- The current guidelines consider cardiovascular disease a critical health outcome measure.
- They also consider a broader set of health outcomes, including adverse birth outcomes, diabetes, obesity and mental well-being. Wherever applicable, incidence, prevalence and mortality were considered separately.
- The current guidelines cover two new noise sources: wind turbines and leisure noise.
- Critical and important health outcomes are considered separately for each of the noise sources.
- The guideline development process included the health effects of intervention measures to mitigate noise exposure from different noise sources for the first time.
- The style of recommendations differs: the current guidelines include an exact exposure value for every health outcome regarded as critical, for each noise source. Guideline recommendation values were set for each of the noise sources separately, based on the exact exposure values and a prioritization scheme, developed with the help of DWs.
- The current guidelines apply a 1 dB increment scheme, whereas prior guidelines (CNG and NNG) formulated or presented recommendations in 5 dB steps.

- In comparison to the 1999 CNG, which defined environment-specific exposure levels, the current guidelines are source specific. They recommend values for outdoor exposure to road traffic, railway, aircraft and wind turbine noise, and indoor as well as outdoor exposure levels for leisure noise.
- Except for leisure noise, all exposure levels recommended in the current guidelines are average sound pressure levels for outdoor exposure.
- The current guidelines make use of the noise indices defined in the END: L_{den} and L_{night}.

The definition of "community noise" used in the CNG in 1999 was also adapted. The GDG agreed to use the term "environmental noise" instead, and offered an operational definition of: "noise emitted from all sources except sources of occupational noise exposure in workplaces".

The current environmental noise guidelines for the European Region supersede the CNG from 1999. Nevertheless, the GDG recommends that all CNG indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) should remain valid.

Furthermore, the current guidelines complement the NNG from 2009. Two main aspects of the NNG constitute this complementarity: the different guiding principles and the comprehensive investigation of the immediate physiological effects of environmental noise on sleep. As guiding principles the NNG defined effect thresholds or "lowest observed adverse health effect levels" for both immediate physiological reactions during sleep (i.e. awakening reactions or body movements during sleep) and long-term adverse health effects (i.e. self-reported sleep disturbance). These guideline exposure levels defined a level below which no effects were expected to occur (corresponding to 30 dB L_{night}) and proceeded to define the level where adverse effects start to occur (corresponding to 40 dB L_{night}), with the aim of protecting the whole population, including – to some extent – vulnerable groups. The development of the NNG values relied on evidence-based expert judgement. In contrast, the current guidelines formulate recommendations more strictly based on the available evidence and following the guiding principle to identify exposure values based on a relevant risk increase of adverse health effects. Thus, the recommended guideline values might not lead to full protection of the population, including all vulnerable groups. The GDG stresses that the aim of the current guidelines is to define an exposure level at which effects certainly begin.

Secondly, the NNG comprehensively investigate the immediate short-term effects of environmental noise during sleep, including physiological reactions such as awakening reactions and body movements. They also provided threshold information about single-event noise indicators (such as the $L_{A,max}$). In contrast, the current guideline values for the night time are only based on the prevalence of self-reported sleep disturbance and do not take physiological effects into account. The causal link between immediate physiological reactions and long-term adverse health effects is complex and difficult to prove. Thus, the current guidelines are restricted to long-term health effects during night time and therefore only include recommendations about average noise indicators: L_{night}. Nevertheless, the evidence review on noise and sleep (Basner & McGuire, 2018) includes an overview of single-event exposure–effect relationships.

3. Recommendations

This chapter presents specific recommendations on guideline exposure levels and/or interventions to reduce exposure and/or improve health for individual sources of noise: road traffic, railway, aircraft, wind turbines and leisure noise. The strength of each recommendation is provided (strong or conditional) and a short rationale for how each of the guideline levels was achieved is given.

The GDG discussed extensively the best way to present guideline exposure levels – either as the exact values or in 5 dB steps – and the approach to rounding the values to the nearest integer. The 5 dB increment, rounded down from the exact exposure value to the nearest 5 dB level, was initially chosen as being commonly applied in noise legislation and used in prior guidelines (WHO, 1999; EC, 2002a; WHO Regional Office for Europe, 2009). It was also used to meet the principle of precaution, since imprecision in the exposure assessment in the field of epidemiology tends to attenuate the actual effects in the population.

Use of 5 dB increments resulted in uneven magnitude of rounding down, however, raising concerns of arbitrariness. It became apparent that inclusion of both exact values and the 5 dB rounded-down values might be confusing and could affect the applicability of the guidelines. Hence, the GDG ultimately decided that formulating recommendations based on the exact calculated values, rounded only to the nearest integer, would ensure more clarity and transparency. Furthermore, it noted that adhering to a 5 dB roster might not reflect the progress in the precision of exposure assessment methods in recent decades, which would justify application of a 1 dB step.

The GDG acknowledged that the recommendations might be presented as the exact guideline exposure levels only, leaving the use of 5 dB bands to the potential policy decisions to formulate or revise noise legislation, which are beyond the scope of this publication. The WHO guideline values are public health-oriented recommendations, based on scientific evidence on health effects and on an assessment of achievable noise levels. They are strongly recommended and as such should serve as the basis for a policy-making process in which policy options are quantified and discussed. It should be recognized that in that process additional considerations of costs, feasibility, values and preferences should also feature in decision-making when choosing reference values such as noise limits for a possible standard or legislation.

In addition to the source-specific recommendations in the following sections, a short rationale for the decision-making process by the GDG for developing a particular recommendation is provided, as well as an overview of the evidence considered. This includes a recapitulation of the specific PICOS/PECCOS question (see section 2.3.1), along with a summary of evidence for each of the critical and important health effects from exposure to each of the noise sources, and for the effectiveness of interventions.

Furthermore, a description is provided of the other factors considered according to the GRADE dimensions for the assessment of the strength of recommendations (see section 2.4.4). While the quality of evidence is central to determining this, the process of moving from evidence to recommendations involves several other considerations. These include values and preferences, balance of benefits and harms, consideration of the priority of the problem, resource implications, equity and human rights aspects, acceptability and feasibility (WHO, 2014c).

3.1 Road traffic noise

Recommendations

For average noise exposure, the GDG **strongly** recommends reducing noise levels produced by road traffic below **53 dB** L_{den}, as road traffic noise above this level is associated with adverse health effects.

For night noise exposure, the GDG **strongly** recommends reducing noise levels produced by road traffic during night time below **45 dB** L_{night}, as road traffic noise above this level is associated with adverse effects on sleep.

To reduce health effects, the GDG **strongly** recommends that policy-makers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions, the GDG recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure.

3.1.1 Rationale for the guideline levels for road traffic noise

The exposure levels were derived in accordance with the prioritization process of critical health outcomes described in section 2.4.3. For each of the outcomes, the exposure level was identified by applying the benchmark, set as relevant risk increase to the corresponding ERF. In the case of exposure to road traffic noise, the process can be summarized as follows (Table 6).

Table 6. Average exposure levels (L_{den}) for priority health outcomes from road traffic noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Incidence of IHD The 5% relevant risk increase occurs at a noise exposure level of 59.3 dB L_{den}. The weighted average of the lowest noise levels measured in the studies was 53 dB L_{den} and the RR increase per 10 dB is 1.08.	5% increase of RR	High quality
Incidence of hypertension One study met the inclusion criteria. There was no significant increase of risk associated with increased noise exposure in this study.	10% increase of RR	Low quality
Prevalence of highly annoyed population There was an absolute risk of 10% at a noise exposure level of 53.3 dB $L_{den.}$	10% absolute risk	Moderate quality
Permanent hearing impairment	No increase	No studies met the inclusion criteria
Reading skills and oral comprehension in children	One-month delay	Very low quality

In accordance with the prioritization process (see section 2.4.3), the GDG set a guideline exposure level of 53.3 dB L_{den} for average exposure, based on the relevant increase of the absolute %HA. It was confident that there was an increased risk for annoyance below this noise exposure level, but probably no increased risk for other priority health outcomes. In accordance with the defined rounding procedure, the value was rounded to 53 dB L_{den}. As the evidence on the adverse effects of road traffic noise was rated moderate quality, the GDG made the recommendation strong.

Next, the GDG assessed the evidence for night noise exposure and its effect on sleep disturbance (Table 7).

Table 7. Night-time exposure levels (L_{night}) for priority health outcomes from road traffic noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Sleep disturbance 3% of the participants in studies were highly sleep-disturbed at a noise level of **45.4 dB** L_{night}	3% absolute risk	Moderate quality

Based on the evidence of the adverse effects of road traffic noise on sleep disturbance, the GDG defined a guideline exposure level of 45.4 dB L_{night}. The exact exposure value was rounded to 45 dB L_{night}. As the evidence was rated moderate quality, the GDG made the recommendation strong.

The GDG also considered the evidence for the effectiveness of interventions. The results showed that:

- addressing the source by improving the choice of appropriate tyres, road surface, truck restrictions or by lowering traffic flow can reduce noise exposure;
- path interventions such as insulation and barrier construction reduce noise exposure, annoyance and sleep disturbance;
- changes in infrastructure such as construction of road tunnels lower noise exposure, annoyance and sleep disturbance;
- other physical interventions such as the availability of a quiet side of the residence reduce noise exposure, annoyance and sleep disturbance.

Given that it is possible to reduce noise exposure and that best practices already exist for the management of noise from road traffic, the GDG made a strong recommendation.

3.1.1.1 Other factors influencing the strength of recommendations

Other factors considered in the context of recommendations on road traffic noise included those related to values and preferences, benefits and harms, resource implications, equity, acceptability and feasibility; moreover, nonpriority health outcomes (the incidence of stroke and diabetes) were considered. Ultimately, the assessment of all these factors did not lead to a change in the strength of the recommendations. Further details are provided in section 3.1.2.3.

3.1.2 Detailed overview of the evidence

The following sections provide a detailed overview of the evidence constituting the basis for setting the recommendations on road traffic noise. It is presented and summarized separately for each of the critical health outcomes, and the GDG's judgement of the quality of evidence is indicated (for a detailed overview of the evidence on important health outcomes, see Annex 4). Research into health outcomes and effectiveness of interventions is addressed consecutively.

A comprehensive summary of all evidence considered for each of the critical and important health outcomes can be found in the eight systematic reviews published in the *International Journal of Environmental Research and Public Health* (see section 2.3.2 and Annex 2).

3.1.2.1 Evidence on health outcomes

The key question posed was: in the general population exposed to road traffic noise, what is the exposure–response relationship between exposure to road traffic noise (reported as various noise indicators) and the proportion of people with a validated measure of health outcome, when adjusted for main confounders? A summary of the PICOS/PECCOS scheme applied (see section 2.3.1) and the main findings is set out in Tables 8 and 9.

Table 8. PICOS/PECCOS scheme of critical health outcomes for exposure to road traffic noise

PECO	Description	
Population	General population	
Exposure	Exposure to high levels of noise produced by road traffic (average/night time)	
Comparison	Exposure to lower levels of noise produced by road traffic (average/night time)	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 9. Summary of findings for health effects from exposure to road traffic noise (L_{den})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)	Quality of evidence
Cardiovascular disease					
L_{den}	Incidence of IHD	RR = 1.08 (95% confidence interval (CI): 1.01–1.15) per 10 dB increase	53 dB	67 224 (7)	High (upgraded for dose-response)
L_{den}	Incidence of hypertension	RR = 0.97 (95% CI: 0.90–1.05) per 10 dB increase	N/A	32 635 (1)	Low (downgraded for risk of bias and because only one study was available)
Annoyance					
L_{den}	%HA	Odds ratio (OR) = 3.03 (95% CI: 2.59–3.55) per 10 dB increase	40 dB	34 112 (25)	Moderate (downgraded for inconsistency)
Cognitive impairment					
L_{den}	Reading and oral comprehension	Not estimated	N/A	Over 2844 (1)	Very low (downgraded for inconsistency)
Hearing impairment and tinnitus					
L_{den}	Permanent hearing impairment	–	–	–	–

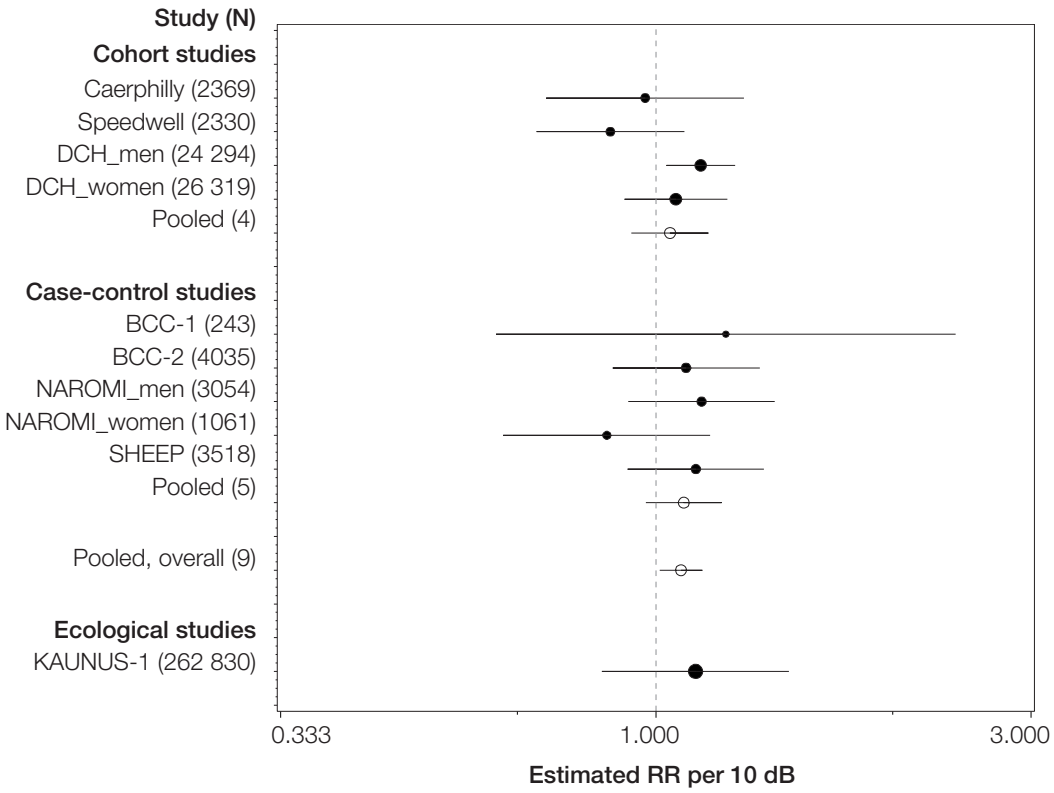
Cardiovascular disease

IHD

A total of three cohort (Babisch & Gallacher, 1990; Babisch et al., 1988; 1993a; 1993b; 1999; 2003; Caerphilly and Speedwell Collaborative Group, 1984; Sörensen et al., 2012a; 2012c) and four case-control studies (Babisch, 2004; Babisch et al., 1992; 1994; 2005a; Selander et al., 2009; Wiens, 1995) investigated the relationship between road traffic noise and the incidence of IHD. These involved a total of 67 224 participants, including 7033 cases. As identified in Fig. 1, the overall RR derived from the meta-analysis was 1.08 (95% CI: 1.01–1.15) per 10 dB L_{den} increase in noise levels, across a noise range of 40 dB to 80 dB. This evidence was rated high quality.

The data were supported by one ecological study conducted with 262 830 participants, including 418 cases, which also reported a statistically significant estimate (Grazuleviciene et al., 2004; Lekaviciute, 2007). In this study, a positive but nonsignificant association was found: RR of 1.12 (95% CI: 0.85–1.48) per 10 dB L_{den} increase in noise. This evidence was rated very low quality.

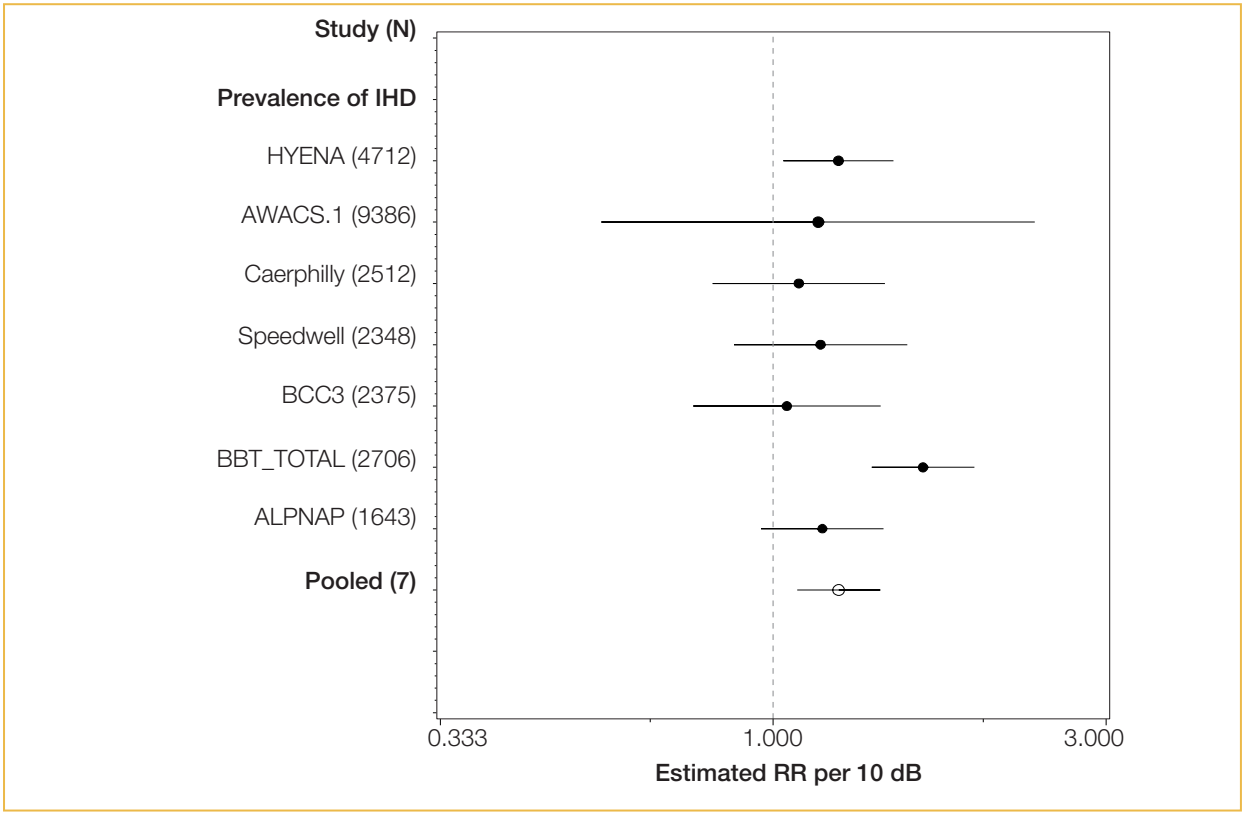
Fig. 1. The association between exposure to road traffic noise (L_{den}) and incidence of IHD



Notes: The dotted vertical line corresponds to no effect of exposure to road traffic noise. The black circles correspond to the estimated RR per 10 dB and 95% CI. The white circles represent the pooled random effect estimates and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Furthermore, additional evidence was available from eight cross-sectional studies that investigated the relationship between road traffic noise and prevalence of IHD (Babisch & Gallacher, 1990; Babisch et al., 1988; 1992; 1993a; 1993b; 1994; 1999; 2003; 2005a; 2008; 2012a; 2012b; Caerphilly and Speedwell Collaborative Group, 1984; Floud et al., 2011; 2013a; 2013b; Heimann et al., 2007; Jarup et al., 2005; 2008; Lercher et al., 2008; 2011; van Poll et al., 2014; Wiens, 1995). These studies involved a total of 25 682 participants, including 1614 cases. The overall RR was 1.24 (95% CI: 1.08–1.42) per 10 dB L_{den} increase in road traffic noise levels. The range in noise levels in the studies under evaluation was 30–80 dB. The results of the meta-analysis are presented in Fig. 2. This evidence was rated low quality.

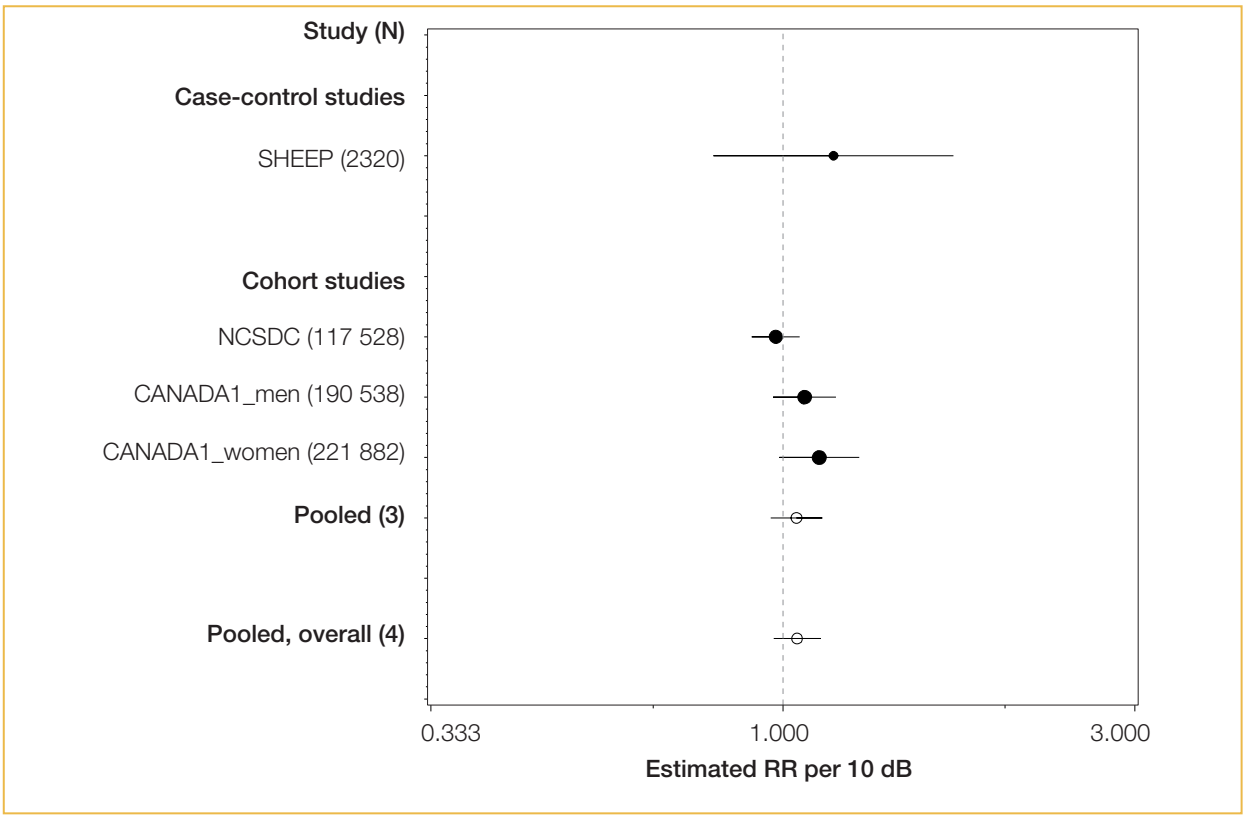
Fig. 2. The association between exposure to road traffic noise (L_{den}) and prevalence of IHD



Notes: The dotted vertical line corresponds to no effect of exposure to road traffic noise. The black circles correspond to the estimated RR per 10 dB and 95% CI. The white circle represents the pooled random effect estimates and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Mortality from IHD was also investigated in one case-control (Selander et al., 2009) and two cohort studies (Beelen et al., 2009; Gan et al., 2012), which involved 532 268 participants, including 6884 cases. The quantitative relationship between road traffic noise and mortality from IHD was RR = 1.05 (95% CI: 0.97–1.13) per 10 dB L_{den} increase in noise levels (see Fig. 3). This evidence was rated moderate quality.

Fig. 3. The association between exposure to road traffic noise (L_{den}) and mortality from IHD



Notes: The dotted vertical line corresponds to no effect of exposure to road traffic noise. The black circles correspond to the estimated RR per 10 dB and 95% CI. The white circles represent the pooled random effect estimates and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Hypertension

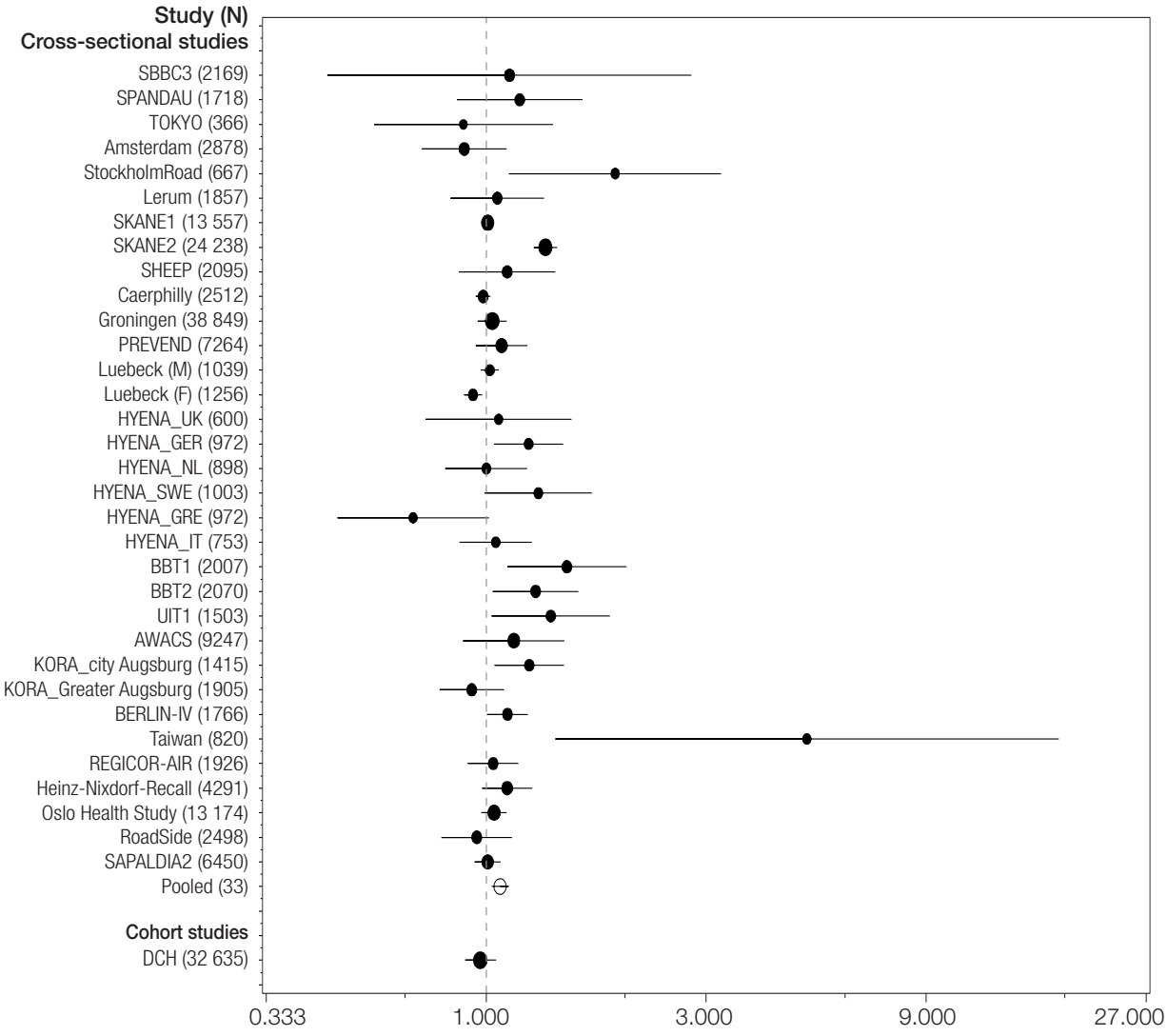
One cohort study into the relationship between road traffic noise and incidence of hypertension was identified; it involved 32 635 participants, including 3145 cases (Sörensen et al., 2011; 2012c). The study found a nonsignificant effect size of 0.97 (95% CI: 0.90–1.05) per 10 dB L_{den} increase in noise levels, which does not support an increased risk of hypertension due to exposure to road traffic noise. Because of the risk of bias and the availability of only one study, this evidence was rated low quality.

In addition, 26 cross-sectional studies were identified that looked at the association between road traffic noise and prevalence of hypertension (Babisch et al., 1988; 1992; 1994; 2005a; 2008; 2012a; 2012b; 2013a; 2013b; 2014b; 2014c; Barregard et al., 2009; Bjork et al., 2006; Bluhm et al., 2007; Bodin et al., 2009; Caerphilly and Speedwell Collaborative Group, 1984; Chang et al., 2011; 2014; de Kluizenaar et al., 2007a; 2007b; Dratva et al., 2012; Eriksson et al., 2012; Foraster et al., 2011; 2012; 2013; 2014a; 2014b; Fuks et al., 2011; Hense et al., 1989; Herbold et al., 1989; Jarup et al., 2005; 2008; Knipschild et al., 1984; Lercher et al., 2008; 2011; Maschke, 2003; Maschke & Hecht,

2005; Maschke et al., 2003; Oftedal et al., 2011; 2014; Selander et al., 2009; van Poll et al., 2014; Wiens, 1995; Yoshida et al., 1997). In total, these studies involved 154 398 participants, including 18 957 cases. The overall RR for prevalence of hypertension was 1.05 (95% CI: 1.02–1.08) per 10 dB L_{den} increase in noise levels. The noise range of the studies under evaluation was 20–85 dB. The overall evidence was rated very low quality.

Fig. 4 shows the association between road traffic noise and incidence and prevalence of hypertension.

Fig. 4. The association between exposure to road traffic noise (L_{den}) and hypertension



Notes: The dotted vertical line corresponds to no effect of exposure to road traffic noise. The black dots correspond to the estimated RR per 10 dB and 95% CI. The white circle represents the summary estimate and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Stroke

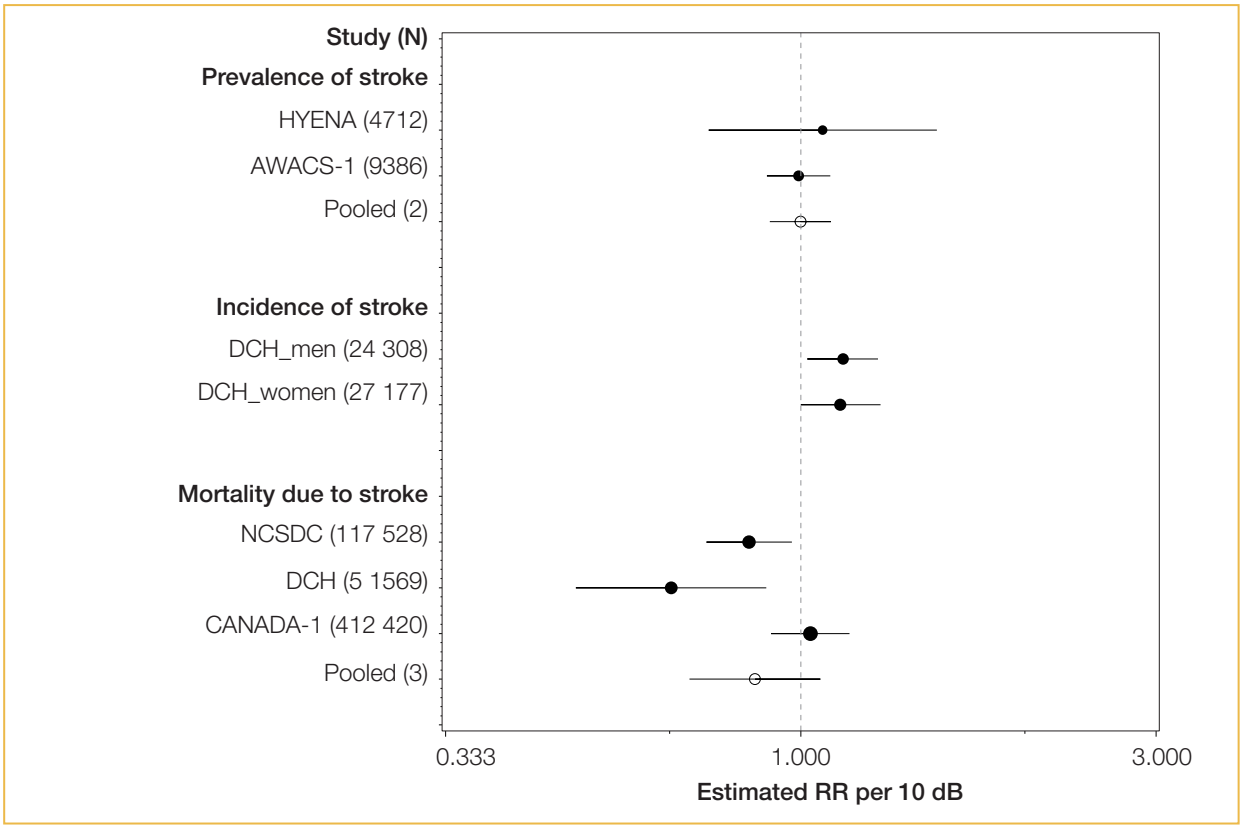
One cohort study into the relationship between road traffic noise and incidence of stroke was identified (Sörensen et al., 2011; 2012b; 2014). It involved 51 485 participants, including 1881 cases, and found an RR of 1.14 (95% CI: 1.03–1.25) per 10 dB L_{den} increase in noise levels, across a range of around 50–70 dB. The evidence was rated moderate quality.

Two cross-sectional studies on road traffic noise and prevalence of stroke involved 14 098 participants, including 151 cases (Babisch et al., 2005a; 2008; 2012a; 2012b; 2013a; Floud et al., 2011; 2013a; 2013b; Jarup et al., 2005; 2008; van Poll et al., 2014) yielded an estimated RR of 1.00 (95% CI: 0.91–1.10) per 10 dB L_{den} increase in noise levels. This evidence was rated very low quality.

Furthermore, three cohort studies investigated the relationship between road traffic noise and mortality due to stroke (Beelen et al., 2009; Gan et al., 2012; Sörensen et al., 2011; 2012b; 2014). These involved 581 517 participants, including 2634 cases, and their pooled estimate was a statistically nonsignificant RR = 0.87 (95% CI: 0.71–1.06) per 10 dB L_{den} increase in road traffic noise levels. This evidence was rated moderate quality.

Fig. 5 presents the results of the meta-analysis for road traffic noise and measures of stroke.

Fig. 5. The association between exposure to road traffic noise (L_{den}) and stroke



Notes: The dotted vertical line corresponds to no effect of exposure to road traffic noise. The black dots correspond to the estimated RR per 10 dB and 95% CI. The white circles represent the summary estimate and 95% CI.
For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Children's blood pressure

Six cross-sectional studies investigated the change in systolic and diastolic blood pressure in children exposed to road traffic noise in residential settings (Belojevic & Evans, 2011; 2012; Bilenko et al., 2013; Liu et al., 2013; 2014; Regecova & Kellerova, 1995; van Kempen et al., 2006). In total, 4197 children were included in these studies; the number of cases was not reported. For each increase in 10 dB L_{den} in noise levels, there was a statistically nonsignificant increase in systolic and in diastolic blood pressure of 0.08 mmHg (95% CI: –0.48–0.64) and 0.47 mmHg (95% CI: –0.30–1.24), respectively. The overall evidence was rated very low quality.

Furthermore, five cross-sectional studies investigated the association between systolic and diastolic blood pressure in children and exposure to road traffic noise in educational settings (Belojevic & Evans, 2011; 2012; Bilenko et al., 2013; Clark et al., 2012; Paunovic et al., 2013; Regecova & Kellerova, 1995; van Kempen et al., 2006). In total, 4520 children were included in these studies; the number of cases was not reported. Systolic blood pressure decreased statistically nonsignificantly, at –0.60 mm (95% CI: –1.51–0.30) per 10 dB L_{den} increase in road traffic noise levels. Diastolic blood pressure increased statistically nonsignificantly, at 0.46 mm (95% CI: –0.60–1.53) per 10 dB L_{den} increase in road traffic noise levels. For both relationships, the evidence was rated very low quality.

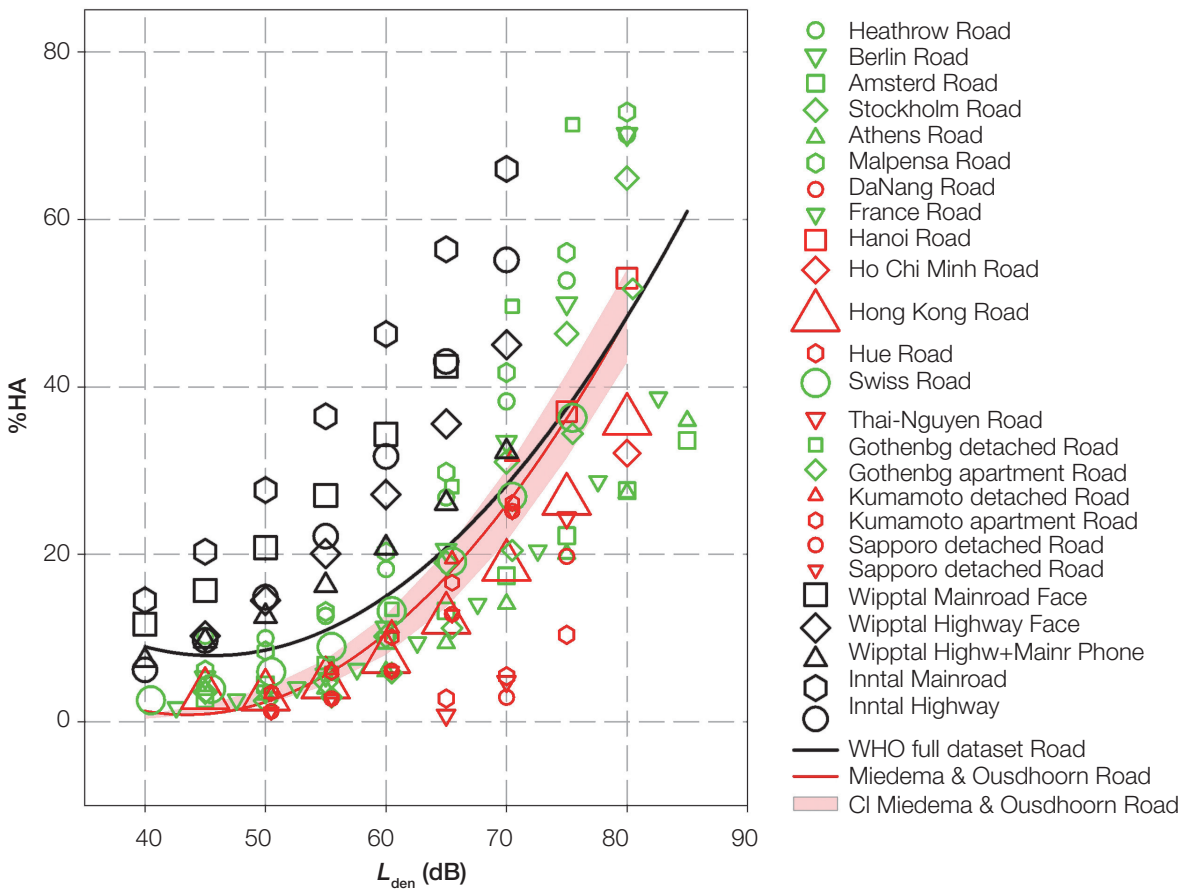
Annoyance

A vast amount of research proves the association between road traffic noise and annoyance. In total, 17 road traffic noise studies were identified that were used to model ERFs of the relationship between L_{den} and %HA (Babisch et al., 2009; Brink, 2013; Brink et al., 2016; Brown et al., 2014; 2015; Champelovier et al., 2003; Heimann et al., 2007; Lercher et al., 2007; Medizinische Universitaet Innsbruck, 2008; Nguyen et al., 2012a; Pierette et al., 2012; Sato et al., 2002; Shimoyama et al., 2014). These incorporated data from 34 112 study participants. The estimated data points of each of the studies are plotted in Fig. 6, alongside an aggregated ERF including the data from all the individual studies (see the black line for "WHO full dataset"). The lowest category of noise exposure considered in any of the studies, and hence included in the systematic review, is 40 dB, corresponding to approximately 9%HA. The benchmark level of 10%HA is reached at 53.3 dB L_{den} (see Fig 6).

Table 10 shows the %HA in relation to exposure to road traffic noise. The calculations are based on the regression equation $\%HA = 78.9270–3.1162 \times L_{den} + 0.0342 \times L_{den}^2$ derived from the systematic review (Guski et al., 2017). Even though there is a large evidence base substantiating the association of average road traffic noise and noise annoyance, the overall evidence had to be rated low quality. The main reasons for downgrading included limitations regarding the acoustical data provided, the nature of study design (most of the studies in the realm of annoyance research follow a cross-sectional approach), the inconsistency of results and the variety in the questions asked.

Nevertheless, the general quality of the evidence was substantiated with the help of additional statistical analyses that apply classic health outcome measures to estimate noise annoyance. When comparing road traffic noise exposure at 50 dB and 60 dB, the analyses revealed evidence rated moderate quality for an association between road traffic noise and %HA for an increase per 10 dB (OR = 2.74; 95% CI: 1.88–4.00). Moreover, there was evidence rated high quality for the increase of %HA per 10 dB increase in sound exposure, when data on all sound classes were included (OR = 3.03; 95% CI: 2.59–3.55).

Fig. 6.Scatterplot and quadratic regression of the relationship between road traffic noise (L_{den}) and annoyance (%HA)



Notes: The ERF by Miedema & Oudshoorn (2001) is added in red for comparison.
The size of the data points corresponds to the number of participants in the respective study (size = SQRT(N)/10).
If two results from different studies fall on the same data point, the last point plotted may mask the former one.
The black curve is derived from aggregated secondary data, while the red one is derived from individual data.
There is no indication of 95% CIs of the WHO full dataset, as a weighting based on the total number of participants for each 5 dB L_{den} sound class could not be calculated; weighting based on all participants of all sound classes proved to be unsuitable. The range of data included is illustrated by the distribution of data points.
For further details on the studies included in the figure please refer to the systematic review on environmental noise and annoyance (Guski et al., 2017).

Table 10. The association between exposure to road traffic noise (L_{den}) and annoyance (%HA)

L_{den} (dB)	%HA
40	9.0
45	8.0
50	8.6
55	11.0
60	15.1
65	20.9
70	28.4
75	37.6
80	48.5

Cognitive impairment

Evidence rated very low quality was available for the association between road traffic noise and reading and oral comprehension, assessed by tests. The review identified two papers that reported the results of the cross-sectional road traffic and aircraft noise exposure and children's cognition and health (RANCH) study, which examined exposure–effect relationships (Clark et al., 2006; Stansfeld et al., 2005). The study of over 2000 children aged 9–10 years, attending 89 schools around three major airports in the Netherlands, Spain and the United Kingdom did not find an exposure–effect relationship between road traffic noise exposure at primary school, which ranged from 31 to 71 dB $L_{Aeq,16h}$, and children's reading comprehension.

Few studies have investigated other health outcome measures related to cognition. Evidence rated low quality was available for an association between road traffic noise and cognitive impairment assessed through standardized tests (Cohen et al., 1973; Lukas et al., 1981; Pujol et al., 2014; Shield & Dockrell, 2008). There was evidence rated very low quality for an association between road traffic noise and long-term memory (Matheson et al., 2010; Stansfeld et al., 2005). No studies examined effects on short-term memory.

There was evidence rated very low quality, however, that road traffic noise does not have a considerable effect on children's attention (Cohen et al., 1973; Stansfeld et al., 2005). Further, there was evidence rated low quality that road traffic noise does not have a substantial effect on executive function (working memory), with studies consistently reporting no association (Clark et al., 2012; Matheson et al., 2010; Stansfeld et al., 2005; van Kempen et al., 2010; 2012).

Hearing impairment and tinnitus

No studies were found, and therefore no evidence was available for the association between road traffic noise and hearing impairment and tinnitus.

Sleep disturbance

For road traffic noise and self-reported sleep outcomes (awakenings from sleep, the process of falling asleep and sleep disturbance), 12 studies were identified that included a total of 20 120

participants (Bodin et al., 2015; Brown et al., 2015; Hong et al., 2010; Phan et al., 2010; Ristovska et al., 2009; Sato et al., 2002; Shimoyama et al., 2014); these were cross-sectional studies, conducted in healthy adults. The health outcome was measured by self-reporting via general health and noise surveys that included questions about sleep in general, and other questions about how noise affects sleep (see Table 11).

Table 11. Summary of findings for health effects from exposure to road traffic noise (L_{night})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)	Quality of evidence
Effects on sleep					
L_{night}	%HSD	OR: 2.13 (95% CI: 1.82–2.48) per 10 dB increase	43 dB	20 120 (12)	Moderate (downgraded for study limitations, inconsistency; upgraded for dose-response, magnitude of effect)

The model in the systematic review (Basner & McGuire, 2018) was based on outdoor L_{night} levels between 40 dB and 65 dB only; 40 dB was chosen as the lower limit because of possible inaccuracies of predicting lower noise levels. The range of noise exposure reported in the studies reviewed was 37.5–77.5 dB L_{night}. About 2% (95% CI: 0.90–3.15) of the population was characterized as highly sleep-disturbed at L_{night} levels of 40 dB. The %HSD at other, higher levels of road traffic noise is presented in Table 12. The association between road traffic noise and the probability of being highly sleep-disturbed was OR: 2.13 (95% CI: 1.82–2.48) per 10 dB increase in noise. This evidence was rated moderate quality.

Table 12. The association between exposure to road traffic noise (L_{night}) and sleep disturbance (%HSD)

L_{night} (dB)	%HSD	95% CI
40	2.0	0.9–3.15
45	2.9	1.40–4.44
50	4.2	2.14–6.27
55	6.0	3.19–8.84
60	8.5	4.64–12.43
65	12.0	6.59–17.36

Additional analyses were conducted for other health outcome measures related to sleep, which provided supporting evidence on the overall relationship between road traffic noise and sleep disturbance. When the noise source was not specified in the question, the relationship between road traffic noise and self-reported sleep outcomes was still positive but no longer statistically significant, with an OR of 1.09 (95% CI: 0.94–1.27) per 10 dB increase (Bodin et al., 2015; Brink, 2011; Frei et al., 2014; Halonen et al., 2012). This evidence was rated very low quality.

There was evidence rated moderate quality for an association between road traffic noise and sleep outcomes measured with polysomnography (probability of additional awakenings) with an OR of 1.36 (95% CI: 1.19–1.55) per 10 dB increase in indoor $L_{AS,max}$ [13] (Basner et al., 2006; Elmenhorst et al., 2012). Further, evidence rated low quality showed an association between road traffic noise and sleep outcomes measured as motility in adults (Frei et al., 2014; Griefahn et al., 2000; Oehrstroem et al., 2006a; Passchier-Vermeer et al., 2007; Pirrera et al., 2014). Finally, there was evidence rated very low quality for an association between road traffic noise and both self-reported and motility-measured sleep disturbance in children (Ising & Ising, 2002; Lercher et al., 2013; Oehrstroem et al., 2006a; Tiesler et al., 2013).

3.1.2.2 Evidence on interventions

This section summarizes the evidence underlying the recommendation on the effectiveness of interventions for road traffic noise exposure. The key question posed was: in the general population exposed to road traffic noise, are interventions effective in reducing exposure to and/or health outcomes from road traffic noise? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 13 and 14.

Table 13. PICOS/PECCOS scheme of the effectiveness of interventions for exposure to road traffic noise

PICO	Description	
Population	**General population**	
Intervention(s)	The interventions can be defined as:	
	(a) a measures that aim to change noise exposure and associated health effects;	
	(b) a measures that aim to change noise exposure, with no particular evaluation of the impact on health; or	
	(c) a measures designed to reduce health effects, but that may not include a reduction in noise exposure.	
Comparison	**No intervention**	
Outcome(s)	For average noise exposure:	For night noise exposure:
	1. cardiovascular disease	1. effects on sleep
	2. annoyance	
	3. cognitive impairment	
	4. hearing impairment and tinnitus	
	5. adverse birth outcomes	
	6. quality of life, well-being and mental health	
	7. metabolic outcomes	

[13] $L_{AS,max}$ is the maximum time-weighted and A-weighted sound pressure level with SLOW time constant within a stated time interval starting at t1 and ending at t2, expressed in dB.

Table 14. Summary of findings for road traffic noise interventions by health outcome

Type of intervention	Number of participants (studies)	Effect of intervention	Quality of evidence
Annoyance			
Type A – source interventions (change in traffic flow rate, improved road resurfacing, truck restriction strategy, complex set of barriers, road surfaces and other measures)	6096[a] (9)	• Changes in noise level ranged from around –15 dB to +15.5 dB (various noise metrics). • Most studies found that the intervention resulted in a change in annoyance.	Moderate (downgraded for study limitations; upgraded for dose-response)
Type B – path interventions (dwelling insulation, barrier construction, building intervention)	2970 (7)	• Changes in noise level ranged from –3 dB to –13 dB (various noise metrics). • All studies found that the intervention resulted in a change in annoyance, as estimated by an ERF.	Moderate (downgraded for study limitations; upgraded for dose-response)
Type C – changes in infrastructure (new road tunnel infrastructure)	1211 (2)	• Noise levels reduced by an average of –12 dB ($L_{Aeq,24h}$). • Both studies found lower annoyance responses post intervention, with no change in the controls.	Moderate (downgraded for study limitations; upgraded for dose-response)
Type D – other physical interventions (availability of quiet side to the dwelling, existence of nearby green space)	26 786 (6)	• Because of large variability in noise levels between most and least exposed façade (quiet side), access to quiet side and/or green space resulted in less annoyance.	Very low (downgraded for study limitations)
Sleep disturbance			
Type B – path interventions (1: façade insulation; 2: enlargement of motorway lanes but with dwelling insulation, barriers and quiet pavement)	1158 (2)	• 1: façade insulation resulted in a reduction of 7 dB for indoor noise level. • 2: enlargement led to reduction in the extent of population exposure at higher noise levels (55–65 dB) with an increase in lower levels (45–55 dB) • Both path interventions resulted in changes in sleep outcomes	Moderate (downgraded for study limitations)
Type C – changes in infrastructure (new road tunnel infrastructure)	166 (2)	• Noise levels reduced by an average of –12 dB ($L_{Aeq,24h}$). • Both studies found lower sleep disturbance indicators/ improvement in sleep post intervention, with no change in the controls.	Moderate (downgraded for study limitations)
Type D – other physical interventions (availability of quiet side to the dwelling)	100 (1)	• An absence of quiet façade resulted in increased reporting of difficulty in falling asleep.	Very low (downgraded for study limitations, inconsistency)
Cardiovascular disease			
Type D – other physical interventions (availability of quiet side to the dwelling)	9203 (4)	• Three studies found changes (including in self-reported hypertension) with and without a quiet side. One study found no change.	Very low (downgraded for study limitations)

Note: [a] This figure does not include number of participants from the studies by Langdon & Griffiths (1982) and Baughan & Huddart (1993), as the exact number of respondents was not reported.

Type A – source interventions

Most of the nine source intervention studies – Baughan & Huddart (1993), Brown (1987; 2015), Brown et al. (1985), Griffiths & Raw (1987; 1989), Kastka (1981), Langdon & Griffiths (1982), Pedersen et al. (2013; 2014), Stansfeld et al. (2009b) – showed an effect in annoyance due to changes in road traffic flow rates. In some cases these were combined with other measures like improved road resurfacing, truck restrictions or complex control measures, including barriers or road surfaces. A majority of the changes resulted in reductions of noise levels.

Regarding the strength of association between exposure and annoyance outcome, all intervention studies demonstrated that the response was of at least the magnitude estimated by a steady-state ERF. The limited available evidence on long-term effects shows that this excess response undergoes some attenuation but is largely maintained over several years. In spite of the high risk of bias in all studies, the evidence in the systematic review was initially assessed as high quality, due to an upgrade because of the dose-response effect. However, the GDG decided to downgrade this assessment in an effort to maximize consistency with the grading approach of the remaining systematic reviews. It was therefore rated moderate quality.

Type B – path interventions

Seven path intervention studies – Amundsen et al. (2011; 2013), Bendtsen et al. (2011), Gidloef-Gunnarsson et al. (2010), Kastka et al. (1995), Nilsson & Berglund (2006), Vincent & Champelovier (1993) – explored the effects on annoyance by interventions related to dwelling insulation, barrier constructions and a combination of both, as well as a full-scale building intervention. With the help of pre/post designs, the studies assessed changes in noise exposure achieved by the interventions over different periods of time. In six studies the path intervention was associated with a change in annoyance outcomes. Four of these showed that the annoyance response to the change was in the same direction and of at least the same magnitude estimated by the ERF. In spite of the high risk of bias in all studies, the evidence in the systematic review was initially assessed as high quality, due to an upgrade because of the dose-response effect. However, the GDG decided to downgrade this assessment in an effort to maximize consistency with the grading approach of the remaining systematic reviews. The evidence was therefore rated moderate quality.

Two of the studies (Amundsen et al., 2013; Bendtsen et al., 2011) assessed path interventions and sleep disturbance. The results showed a reduction in the %HSD after the interventions were conducted. One of the studies included a two-year follow-up, revealing the persistence of the effect. Risk of bias was assessed as high in both studies. The evidence was rated moderate quality.

Type C – new/closed infrastructure interventions

Two infrastructural intervention studies (Gidloef-Gunnarsson et al., 2013; Oehrstroem, 2004; Oehrstroem & Skanberg, 2000) evaluated the impact on annoyance of major reductions in road traffic flows, combined with other environmental improvements. One was a new road tunnel infrastructure, resulting in substantial traffic and noise levels reductions for residents near the previously heavy-traffic road. Both studies were pre/post designs using repeated measures of annoyance outcomes. Following the reduction in noise levels (around –12 dB $L_{Aeq,24h}$), both studies demonstrated a statistically significant lower degree of annoyance, while there was no change in

the control group. Both also reported that the after-scores in the studies matched those estimated by the ERF, but both reported excess response, meaning that the response to change was in the direction estimated by the ERF but much steeper. In spite of the high risk of bias in all studies, the quality of the evidence in the systematic review was initially assessed as high, due to an upgrade because of the dose-response effect. However, the GDG decided to downgrade this assessment in an effort to maximize consistency with the grading approach of the remaining systematic reviews. The evidence was therefore rated moderate quality.

Two studies investigated the impact of new tunnels that removed traffic flow from surface roads on sleep disturbance (Oehrstroem, 2004; Oehrstroem & Skanberg, 2000; 2004). Subjective and objective measures of sleep quality were assessed before and after the intervention. Both studies demonstrated a statistically significant lower reporting of various sleep disturbance indicators post intervention. One study reported statistically significantly reduced time spent in bed after the intervention, which, according to the authors, could suggest increased sleep efficiency. Risk of bias was assessed as high, so this evidence was rated moderate quality.

Type D – other physical infrastructure interventions

No intervention studies were available to assess impacts on annoyance of other physical interventions. The only relevant studies (Babisch et al., 2012; de Kluizenaar et al, 2011; 2013; Gidloef-Gunnarsson & Oehrstroem 2007; van Renterghem & Botteldooren, 2012; 2010) did not provide direct evidence of an intervention. Instead, they provided indirect evidence on the magnitude of the likely effect of certain interventions (e.g. using the quiet side of the dwelling, green space in the neighbourhood) by comparing responses from groups with and without the intervention/feature of interest. All studies found an effect of the presence of the dimension investigated; in all but one, the effect was statistically significant. Risk of bias was assessed as high in all studies, so the evidence was rated very low quality.

One study investigated a subjective assessment of difficulty in falling asleep (van Renterghem & Botteldooren, 2012), before and after the intervention. The difference in the proportion of participants reporting difficulty falling asleep “at least sometimes” between homes with and without a quiet side was statistically significant. Absence of a quiet façade resulted in increased reporting of this sleep parameter. Confounding was adjusted for in the analyses of the ERFs, including noise sensitivity, window-closing behaviour and front-façade L_{den}. Risk of bias was assessed as high, so the evidence was rated very low quality.

Four studies that assessed the effect of other physical interventions on cardiovascular disease were identified (Babisch et al., 2012; 2014a; Bluhm et al., 2007; Lercher et al., 2011). Three of these found changes, including self-reported hypertension, with and without a quiet side of the dwelling; in two the difference was statistically significant. The risk of bias in these studies was generally high, so the evidence was rated very low quality.

3.1.2.3 Consideration of additional contextual factors

As the foregoing overview has shown, ample evidence about the adverse health effects of long-term exposure to road traffic noise exists. Based on the quality of the available evidence, the GDG set the strength of the recommendation on road traffic noise at strong. As a second step, it qualitatively

assessed contextual factors to explore whether other considerations could have a relevant impact on the recommendation strength. These considerations mainly concerned the balance of harms and benefits, values and preferences, equity, and resource use and implementation.

When assessing the balance of harms and benefits of interventions to reduce exposure to road traffic noise, the GDG initially noted that road traffic is the most widespread source of noise pollution, measured in terms of the number of affected people both within and outside urban areas. The EEA estimates that more than 100 million people in Europe are exposed to L_{den} levels above 55 dB; for night-time road traffic noise, over 72 million Europeans are exposed to L_{night} levels above 50 dB (Blanes et al., 2017).[14] The amount of road traffic noise emitted is unlikely to decrease significantly: both transport demand, including for passenger cars (EC, 2016b), and the number of city inhabitants (Eurostat, 2016) are expected to increase. Considering the significant burden of disease attributable to exposure to road traffic noise (WHO Regional Office for Europe & JRC, 2011), the GDG expects substantial health benefits to evolve from implementing the recommendations to reduce population exposure to road traffic noise. Depending on the intervention measures used (such as restrictions of traffic), possible harms could include effects on the transportation of goods and on individual mobility of the population. Both can have impacts on local, national and international economies. Overall, the GDG estimated that the benefits gained from minimizing adverse health effects due to road traffic noise exposure outweigh the possible (economic) harms.

Considering values and preferences, it has been established that people appreciate quiet areas as beneficial for their health and well-being, especially in urban areas (Shepherd et al., 2013; Gidloef-Gunnarsson & Oehrstroem, 2007; Oehrstroem et al., 2006b). Nevertheless, the GDG recognized that the convenience of individual mobility with the help of passenger cars is valued overall by large parts of the population in the EU, as illustrated by the sustained high volume of passenger kilometres driven in Europe (EEA, 2016a; 2017a). In general, values and preferences are expected to vary throughout society, as exposure to environmental noise and continuous road traffic noise is not equally distributed: those of individuals directly affected by long-term road traffic exposure are likely to differ from those that are not affected. Individuals with a higher average sound pressure level of road traffic noise are, for example, more willing to pay to reduce their noise exposure (Bristow et al., 2014).

In light of the dimension of equity, the GDG highlighted the fact that the risk of exposure to road traffic noise is not equally distributed throughout society. People with lower socioeconomic status and other disadvantaged groups often live in more polluted and louder areas, including in proximity to busy roads (EC, 2016a). Moreover, socioeconomic factors are not only related to differences in exposure to environmental factors such as noise but are also associated with increased vulnerability and poorer coping capacities (Karpati et al., 2002).

With resource use and implementation considerations, the GDG recognized that no comprehensive cost–benefit analysis for the WHO European Region yet exists, so this assessment is based on informed expert judgement regarding the feasibility of implementing the recommendation for the majority of the population. As the systematic review of environmental noise interventions and their

[14] These are gap-filled figures based on the reported data and including the situation both within and outside cities, as defined by the END.

associated impact on health shows, various effective measures exist to reduce noise exposure from road traffic and improve health (Brown & van Kamp, 2017). The resources needed to implement these measures vary as they rely on the type of intervention and the context. The GDG pointed out the following four major solutions, which are known to be cost-effective: choice of appropriate tyres, use of low-noise road surfaces, building of noise barriers and installation of soundproof windows (CSES et al., 2016). Other types of intervention include limitations of speed or type of traffic allowed on roads.

Regarding feasibility of implementation, the GDG was convinced that many of the solutions can be planned as part of regular maintenance processes and accelerated fleet and road modernization. In particular, appropriate tyres and road surfaces are only slightly more expensive than existing products, and various countries have already considered or adopted similar interventions to reduce noise levels (Ohiduzzaman et al., 2016; Sirin, 2016). This indicates that solutions to achieve recommended noise levels can be implemented and carry a reasonable cost on a societal level. The GDG noted, however, that the feasibility of implementing measures can be hindered by the fact that costs and benefits are not evenly distributed. In most cases, the health benefits gained by interventions that reduce long-term road traffic exposure accrue to citizens, whereas the costs are borne by road users, private companies and public authorities. Furthermore, the GDG expects challenges in the implementation of all long-term measures that include changes in behaviour of the population, such as increased use of car-sharing or public transport. Even though the overall costs are expected to be significant, because of the large number of people affected, the benefit of implementation of the recommendation to minimize the risk of adverse health effects due to road traffic noise for a majority of the population exceeds the resources needed.

In light of the assessment of the contextual factors in addition to the quality of evidence, the recommendation remains strong.

Other nonpriority adverse health outcomes

As an additional consideration, although not priority health outcomes and coming from a single study, the GDG noted the evidence rated moderate quality for an association between road traffic noise and the prevalence of diabetes (van Kempen et al., 2018). The noise levels in the study identified ranged from around 50 dB to 70 dB L_{den}, so the recommendation proposed is thought to be protective enough for this health outcome. Thus, it did not lead to a change in the recommendation.

Additional considerations or uncertainties

Individual noise annoyance judgements of residents are to a large extent moderated by personal variables (such as noise sensitivity and coping capacity). However, further situational factors that apply to many residents should be taken into account when analysing noise annoyance from road traffic noise, as they may moderate the relationship. These include the type(s) of road being considered (highways, urban main roads, secondary roads and so on) and the related traffic composition (share of cars, motorcycles and heavy and loud trucks) and pattern (fluctuation, frequency, intermittency). Moreover, the location of settlements and/or individual dwellings, proximity to the road, and location and availability of a quiet façade can also influence the relationship when predicting health outcomes such as annoyance.

3.1.3 Summary of the assessment of the strength of the recommendations

Table 15 provides a comprehensive summary of the different dimensions for the assessment of the strength of the road traffic noise recommendations.

Table 15. Summary of the assessment of the strength of the road traffic noise recommendation

Factors influencing the strength of recommendation	Decision
Quality of evidence	**Average exposure** (L_{den}) *Health effects* • Evidence for a relevant RR increase for incidence of IHD at **59 dB** L_{den} was rated **high quality**. • Evidence for the incidence of hypertension was rated **low quality**. • Evidence for a relevant absolute risk of annoyance at **53 dB** L_{den} was rated **moderate quality**. • Evidence for a relevant RR increase for reading and oral comprehension was rated **very low quality**. *Interventions* • Evidence on effectiveness of interventions to reduce noise exposure and/or health outcomes from road traffic noise is of varying quality. **Night-time exposure** (L_{night}) *Health effects* • Evidence for a relevant absolute risk of sleep disturbance related to night noise exposure from road traffic at **45 dB** L_{night} was rated **moderate quality**. *Interventions* • Evidence on effectiveness of interventions to reduce noise exposure and/or sleep disturbance from road traffic noise is of varying quality.
Balance of benefits versus harms and burdens	Health benefits can be gained from markedly reducing exposure of the population to road traffic noise; benefits outweigh the harms of interventions to reduce continuous road traffic noise.
Values and preferences	Quiet areas are valued by the population, especially by those affected by continuous noise exposure. Some variability is possible between those who benefit from interventions to reduce road traffic noise and those who finance the interventions.
Equity	Risk of exposure to road traffic noise is not equally distributed.
Resource use and implications	No comprehensive cost–effectiveness analysis data are available; nevertheless, a wide range of solutions exists and several are being implemented, showing that effective interventions are both feasible and economically reasonable.
Decisions on recommendation strength	• **Strong** for guideline level for average noise exposure (L_{den}) • **Strong** for guideline value for average night noise exposure (L_{night}) • **Strong** for specific interventions to reduce noise exposure

3.2 Railway noise

Recommendations

For average noise exposure, the GDG **strongly** recommends reducing noise levels produced by railway traffic below **54 dB** L_{den}, as railway noise above this level is associated with adverse health effects.

For night noise exposure, the GDG **strongly** recommends reducing noise levels produced by railway traffic during night time below **44 dB** L_{night}, as railway noise above this level is associated with adverse effects on sleep.

To reduce health effects, the GDG **strongly** recommends that policy-makers implement suitable measures to reduce noise exposure from railways in the population exposed to levels above the guideline values for average and night noise exposure. There is, however, insufficient evidence to recommend one type of intervention over another.

3.2.1 Rationale for the guideline levels for railway noise

The exposure levels were derived in accordance with the prioritizing process of critical health outcomes described in section 2.4.3. For each of the outcomes, the exposure level was identified by applying the benchmark, set as relevant risk increase to the corresponding ERF. In the case of exposure to railway noise, the process can be summarized as follows (Table 16).

Table 16. Average exposure levels (L_{den}) for priority health outcomes from railway noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Incidence of IHD No studies were available and therefore incidence of IHD could not be used to assess the exposure level.	5% increase of RR	No studies met the inclusion criteria/no studies available
Incidence of hypertension One study met the inclusion criteria. There was no significant increase of risk associated with increased noise exposure in this study.	10% increase of RR	Low quality
Prevalence of highly annoyed population There was an absolute risk of 10% at a noise exposure level of 53.7 dB $L_{den.}$	10% absolute risk	Moderate quality
Permanent hearing impairment	No increase	No studies met the inclusion criteria/no studies available
Reading skills and oral comprehension in children	One-month delay	No studies met the inclusion criteria/no studies available

In accordance with the prioritization process (see section 2.4.3), the GDG set a guideline exposure level of 53.7 dB L_{den} for average exposure, based on the relevant increase of the absolute %HA. In accordance with the defined rounding procedure, the value was rounded to 54 dB L_{den}. As the evidence on the adverse effects of railway noise was rated moderate quality, the GDG made the recommendation strong.

Next, the GDG assessed the evidence for night noise exposure and its effect on sleep disturbance (Table 17).

Table 17. Night-time exposure levels (L_{night}) for priority health outcomes from railway noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Sleep disturbance 3% of the participants in studies were highly sleep-disturbed at a noise level of **43.7 dB** L_{night}	3% absolute risk	Moderate quality

Based on the evidence of the adverse effects of railway noise on sleep disturbance, the GDG defined a guideline exposure level of 43.7 dB L_{night}. The exact exposure value was rounded to 44 dB L_{night}. As the evidence was rated moderate quality, the GDG made the recommendation strong.

The GDG also considered the evidence for the effectiveness of interventions. The results showed that:

- intervening at the source by applying rail grinding procedures can reduce noise annoyance;
- behavioural interventions such as informing the community about noise interventions can reduce noise annoyance.

In light of the strong evidence about the adverse health effects, the GDG followed a precautionary approach and made a strong recommendation for interventions on railway noise, as it was confident that interventions are realizable and that best practices already exist for the management of noise from railways. Since the empirical evidence on the effectiveness of different types of intervention was rated either low or very low quality, the GDG felt that no recommendation could be made on the preferred type of intervention, and agreed not to recommend any specific type of intervention over another.

3.2.1.1 Other factors influencing the strength of recommendations

Other factors considered in the context of recommendations on railway noise included those related to values and preferences, benefits and harms, resource implications, equity, acceptability and feasibility; moreover, nonpriority health outcomes were considered. The assessment of all these factors – especially the values and preferences involved in railway noise – did not lead to a change in the strength of the recommendations. Further details are provided in Section 3.2.2.3.

3.2.2 Detailed overview of the evidence

The following sections provide a detailed overview of the evidence constituting the basis for setting the recommendations on railway noise. It is presented and summarized separately for each of the critical health outcomes, and the GDG's judgement of the quality of evidence is indicated (for a detailed overview of the evidence on important health outcomes, see Annex 4). Research into health outcomes and effectiveness of interventions is addressed consecutively.

A comprehensive summary of all evidence considered for each of the critical and important health outcomes can be found in the eight systematic reviews published in the *International Journal of Environmental Research and Public Health* (see section 2.3.2 and Annex 2).

3.2.2.1 Evidence on health outcomes

The key question posed was: in the general population exposed to railway noise, what is the exposure–response relationship between exposure to railway noise (reported as various noise indicators) and the proportion of people with a validated measure of health outcome, when adjusted for main confounders? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 18 and 19.

Table 18. PICOS/PECCOS scheme of critical health outcomes for exposure to railway noise

PECO	Description	
Population	General population	
Exposure	Exposure to high levels of noise produced by railway traffic (average/night time)	
Comparison	Exposure to lower levels of noise produced by railway traffic (average/night time)	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 19. Summary of findings for health effects from exposure to railway noise (L_{den})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)[a]	Quality of evidence
Cardiovascular disease					
L_{den}	Incidence of IHD	–	–	–	–
L_{den}	Incidence of hypertension	RR = 0.96 (95% CI: 0.88–1.04) per 10 dB increase	N/A	7249 (1)	Low (downgraded for risk of bias and availability of only one study)
Annoyance					
L_{den}	%HA	OR = 3.53 (95% CI: 2.83–4.39) per 10 dB increase	34	10 970 (10)	Moderate (downgraded for inconsistency, directness; upgraded for dose-response)
Cognitive impairment					
L_{den}	Reading and oral comprehension	–	–	–	–
Hearing impairment and tinnitus					
L_{den}	Permanent hearing impairment	–	–	–	–

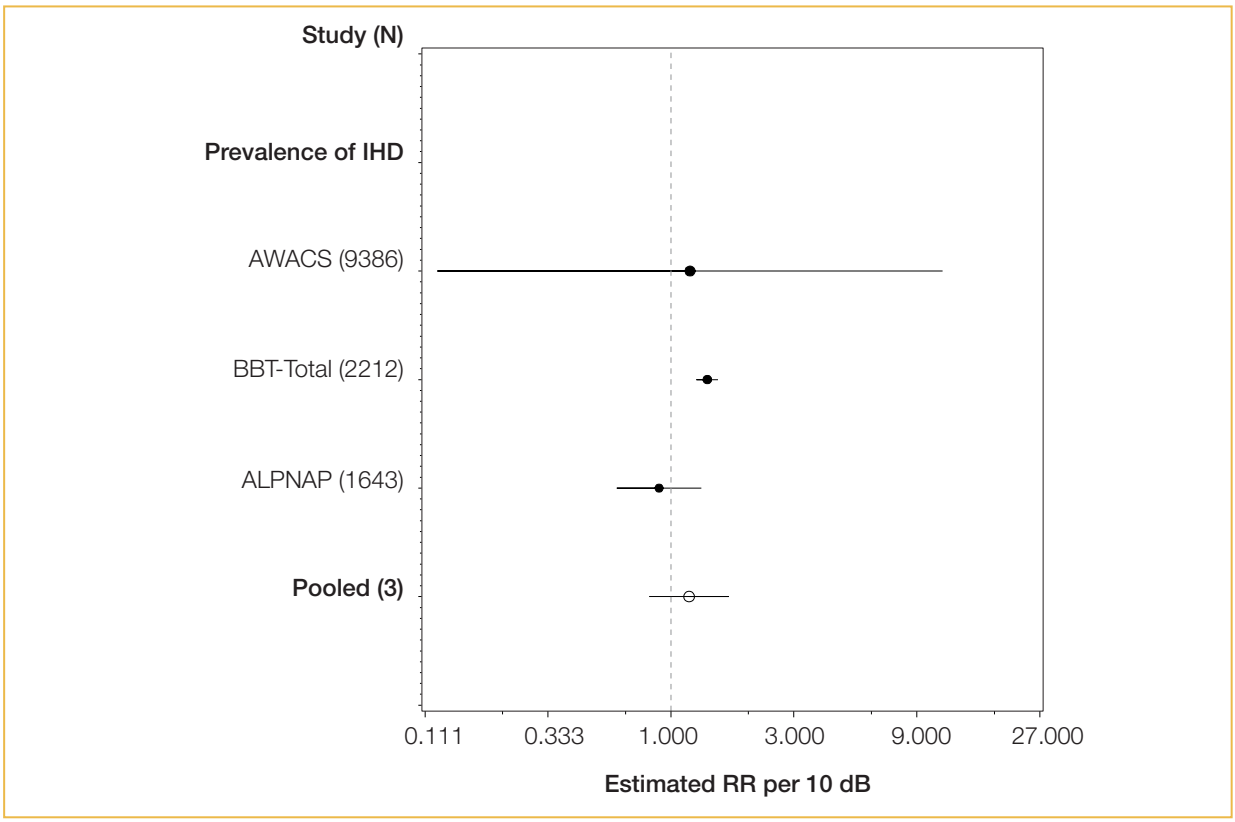
Note: [a] Results are partly derived from population-based studies.

Cardiovascular disease

IHD

No evidence was available on the relationship between railway noise and the incidence of or mortality from IHD. Four cross-sectional studies were identified, however, that assessed the prevalence of IHD in a total of 13 241 participants, including 283 cases (Heimann et al., 2007; Lercher et al., 2008; 2011; van Poll et al., 2014). The overall risk was not statistically significantly increased: the RR was 1.18 (95% CI: 0.82–1.68) per 10 dB L_{den} increase, with inconsistency across studies (see Fig. 7). The evidence was rated very low quality.

Fig. 7. The association between exposure to railway noise (L_{den}) and prevalence of IHD



Notes: The dotted vertical line corresponds to no effect of exposure to railway noise. The black circles correspond to the estimated RR per 10 dB and 95% CI. The white circle represents the pooled random effect estimates and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

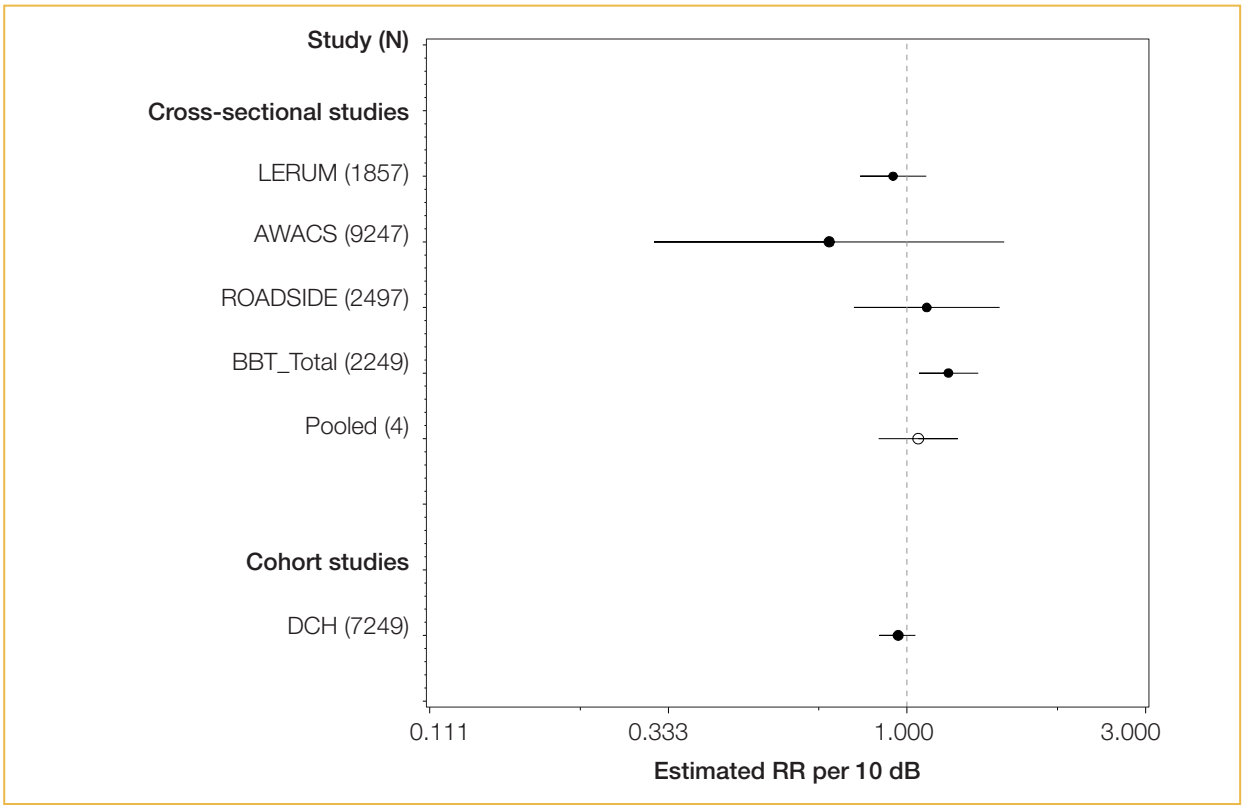
Hypertension

One cohort study on the relationship between railway noise and hypertension was identified; it assessed the incidence among people living in Denmark (Sörensen et al., 2011; 2012a). The study involved 7249 participants, including 3145 cases. The authors did not find an association between railway noise exposure and incidence of hypertension, with RR = 0.96 (95% CI: 0.88–1.04) per 10 dB L_{den} increase. This evidence was rated low quality.

In addition, five cross-sectional studies assessed the prevalence of hypertension in 15 850 participants, including 2059 cases (Barregard et al., 2009; Eriksson et al., 2012; Lercher et al., 2008; 2011; van Poll et al., 2014). The overall RR increase was not statistically significant, at 1.05 (95% CI: 0.88–1.26) per 10 dB L_{den} increase. Moreover, there was inconsistency among the results across studies. The evidence was rated very low quality.

Fig. 8 presents the studies investigating the relationship between railway noise and different measures of hypertension.

Fig. 8. The association between exposure to railway noise (L_{den}) and hypertension



Notes: The dotted vertical line corresponds to no effect of exposure to railway noise. The black dots correspond to the estimated RR per 10 dB and 95% CI. The white circle represents the summary estimate and 95% CI.
For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Stroke

As for IHD, no evidence was available on the relationship between railway noise and incidence of or mortality from stroke. However, one cross-sectional study was identified that assessed the prevalence of stroke in 9365 participants, including 89 cases (van Poll et al., 2014). The overall risk was not statistically significantly increased, with RR = 1.07 (95% CI: 0.92–1.25) per 10 dB L_{den} increase. The evidence was rated very low quality.

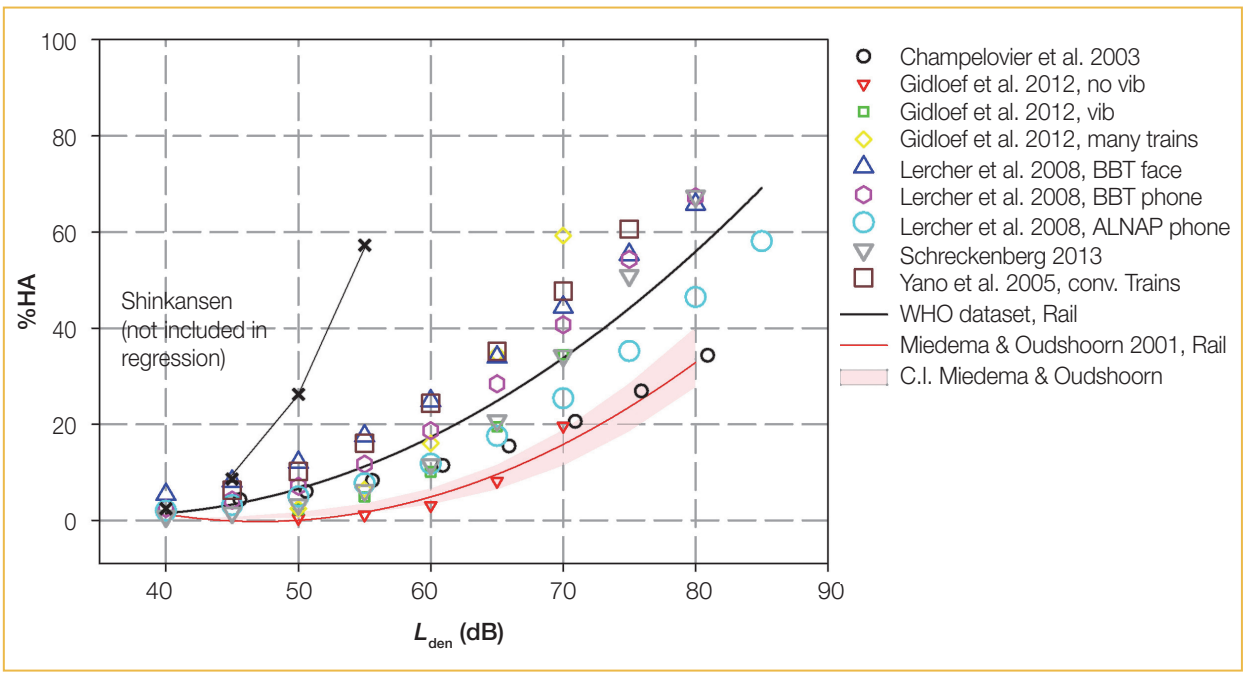
Children's blood pressure

No evidence was available for the association between railway noise and the systolic and/or diastolic blood pressure of children in residential and/or educational settings.

Annoyance

In total, 10 studies with ERFs on the association between railway noise and annoyance were included in analyses (Champelovier et al., 2003; Gidloef-Gunnarsson et al., 2012; Lercher et al., 2007; 2008; Sato et al., 2004; Schreckenberg, 2013; Yano et al., 2005; Yokoshima et al., 2008). The studies incorporated individual data from 10 970 participants. The estimated data points of each of these studies are plotted in Fig. 9, alongside an aggregated ERF including the data from all the individual studies (see the black line for "WHO dataset, Rail"). The lowest category of noise exposure considered in any of the studies, and hence included in the systematic review is 40 dB, corresponding to approximately 1.5%HA. The 10% benchmark for %HA is reached at 53.7 dB L_{den} (see Fig. 9).

Fig. 9. Scatterplot and quadratic regression of the relationship between railway noise (L_{den}) and annoyance (%HA)



Notes: The ERF by Miedema & Oudshoorn (2001) is added in red for comparison.
There is no indication of 95% CIs of the WHO dataset curve, as a weighting based on the total number of participants for each 5 dB L_{den} sound class could not be calculated; weighting based on all participants of all sound classes proved to be unsuitable. The range of data included is illustrated by the distribution of data points.
For further details on the studies included in the figure please refer to the systematic review on environmental noise and annoyance (Guski et al., 2017).

Table 20 shows the %HA for railway noise exposure. The calculations are based on the regression equation %HA = 38.1596–2.05538 × L_{den} + 0.0285 × L_{den}^2 derived from the systematic review (Guski et al., 2017). The overall evidence was rated moderate quality. Additional statistical analyses of annoyance outcomes supported these findings. When comparing railway noise exposure at 50 dB and 60 dB, the analyses revealed evidence rated moderate quality for an association between railway noise and %HA for an increase per 10 dB (OR = 3.40; 95% CI: 2.05–5.62). Moreover, evidence rated high quality was available for the increase in %HA per 10 dB increase in sound exposure, when data on all sound classes were included (OR = 3.53; 95% CI: 2.83–4.39).

Table 20. The association between exposure to railway noise (L_{den}) and annoyance (%HA)

L_{den} (dB)	%HA
40	1.5
45	3.4
50	6.6
55	11.3
60	17.4
65	25.0
70	33.9
75	44.3
80	56.1

Cognitive impairment

Studies of railway noise on children's reading and oral comprehension were lacking. Nevertheless, other measures of cognition yielded evidence rated very low quality for an association between railway noise and children with poorer performance on standardized assessment tests (Bronzaft, 1981; Bronzaft & McCarthy, 1975). Evidence for the association between railway noise and children having poorer long-term memory (Lercher et al., 2003) was rated very low quality. No studies examined effects on short-term memory.

There was no clear relation between railway noise and attention in children (Lercher et al., 2003), and this evidence was rated very low quality.

Hearing impairment and tinnitus

No studies were found, and therefore no evidence was available on the association between railway noise and hearing impairment and tinnitus.

Sleep disturbance

For railway noise and self-reported sleep outcomes (awakenings from sleep, the process of falling asleep and sleep disturbance), five studies were identified that included a total of 7133 participants (Bodin et al., 2015; Hong et al., 2010; Sato et al., 2004; Schreckenberg, 2013). The studies were cross-sectional and conducted on healthy adults. The health outcome was measured by self-reporting via general health surveys and noise surveys that included questions about sleep in general, and other questions about how noise affects sleep (Table 21).

Table 21. Summary of findings for health effects from exposure to railway noise (L_{night})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)	Quality of evidence
Effects on sleep					
L_{night}	%HSD	OR: 3.06 (95% CI: 2.38–3.93) per 10 dB increase	33 dB	7133 (5)	Moderate (downgraded for study limitations, inconsistency; upgraded for dose-response, magnitude of effect)

The model in the systematic review (Basner & McGuire, 2018) was based on outdoor L_{night} levels between 40 dB and 65 dB only; 40 dB was chosen as the lower limit because of possible inaccuracies in predicting lower noise levels. The range of noise exposure reported in the studies was 27.5–82.5 dB L_{night}. About 2% (95% CI: 0.79–3.48) of the population was characterized as highly sleep-disturbed for L_{night} levels of 40 dB. The %HSD at other, higher levels of railway noise is presented in Table 17. The association between railway noise and the probability of being sleep-disturbed was OR: 3.1 (95% CI: 2.4–3.9) per 10 dB increase in noise. This evidence was rated moderate quality.

Table 22. The association between exposure to railway noise (L_{night}) and sleep disturbance (%HSD)

L_{night} (dB)	%HSD	95% CI
40	2.1	0.79–3.48
45	3.7	1.63–5.71
50	6.3	3.12–9.37
55	10.4	5.61–15.26
60	17.0	9.48–24.37
65	26.3	15.20–37.33

Additional analyses were conducted for sleep quality measures, which provided supporting evidence on the overall relationship between railway noise and sleep. When the noise source was not specified in the question, the relationship between railway noise and self-reported sleep outcomes was still positive but no longer statistically significant, with an OR of 1.27 (95% CI: 0.89–1.81) per 10 dB increase (Bodin et al., 2015; Brink, 2011; Frei et al., 2014). This evidence was rated very low quality.

There was evidence rated moderate quality for an association between railway noise and the probability of additional awakenings, measured with polysomnography, with an OR of 1.35 (95% CI: 1.21–1.52) per 10 dB increase in indoor $L_{AS,max}$ (Elmenhorst et al., 2012). Finally, evidence rated low quality was available for an association between railway noise and sleep outcomes measured as motility in adults (Griefahn et al., 2000; Hong et al., 2006; Lercher et al., 2010; Passchier-Vermeer et al., 2007), and rated very low quality for an association between railway noise and both self-reported and motility-measured sleep disturbance in children (Ising & Ising, 2002; Lercher et al., 2013; Tiesler et al., 2013).

3.2.2.2 Evidence on interventions

This section summarizes the evidence underlying the recommendation on the effectiveness of interventions for railway noise exposure (Tables 23 and 24). The key question posed was: in the

general population exposed to railway noise, are interventions effective in reducing exposure to and/or health outcomes from railway noise? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 23 and 24.

Table 23. PICOS/PECCOS scheme of the effectiveness of interventions for exposure to railway noise

PICO	Description	
Population	**General population**	
Intervention(s)	The interventions can be defined as: (a) a measure that aims to change noise exposure and associated health effects; (b) a measure that aims to change noise exposure, with no particular evaluation of the impact on health; or (c) a measure designed to reduce health effects, but that may not include a reduction in noise exposure.	
Comparison	**No intervention**	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 24. Summary of findings for railway noise interventions by health outcome

Type of intervention	Number of participants (studies)	Effect of intervention	Quality of evidence
Annoyance			
Type A – source interventions (rail grinding)	81 (1)	• Changes in noise level as a consequence of the intervention ranged from around –7dB to –8 dB. • Most studies found changes in annoyance outcomes, persisting more than 12 months after the intervention.	Very low (downgraded for study limitations, inconsistency, imprecision)
Type C – changes in infrastructure (new rail infrastructure)	6000[a] (1)	• A very small increase in total noise exposure was found (most had <+1 dB change; some had +2–4 dB change). • Original noise from road traffic overwhelmed the train noise for effectively all participants.	Very low (downgraded for study limitations, inconsistency, imprecision)
Type E – behaviour change interventions (informing the community about a noise intervention)	411 (1)	• Exposure levels were not reported; emission levels reduced by 1–2 dB. • A reduction in annoyance of the community as a result of the intervention was reported.	Very low (downgraded for study limitations, inconsistency, imprecision)

Note: [a] According to Lam & Au (2008), this records the number of invitation letters sent; the response rate was not reported.

Three studies on railway noise interventions met the criteria to be included in the evidence base. All studies consisted of a pre/post design and reported annoyance outcomes at people's dwellings (Lam & Au, 2008; Moehler et al., 1997; Schreckenberg et al., 2013). They could be categorized as a source intervention, a new/closed infrastructure intervention and a communication intervention. In two of the studies, the changes in exposure after the intervention were only small, although there were significant effects on noise annoyance. The study on source interventions and annoyance revealed that a change of –10 dB in noise exposure led to a significant reduction in annoyance, which persisted over a period of 12 months after the intervention. As confounding was not addressed, and railway noise was not the dominant sound source in the studies, the evidence was rated very low quality.

3.2.2.3 Consideration of additional contextual factors

As the foregoing overview has shown, sufficient evidence about the adverse health effects of long-term exposure to railway noise exists. Based on the quality of the available evidence, the GDG set the strength of recommendation on railway noise at strong. As a second step, it qualitatively assessed contextual factors to explore whether other considerations could have a relevant impact on the recommendation strength. These contextual considerations mainly concerned the balance of harms and benefits, values and preferences, and resource use and implementation.

When assessing the balance of harms and benefits of interventions to reduce exposure to railway noise and minimize noise-associated adverse health effects, the GDG recognized that railway transportation is the second most dominant source of environmental noise in Europe. Based on EEA estimates, the number of people exposed to L_{den} above 55 dB and L_{night} above 50 dB from railway noise is 17 million and 15 million, respectively (Blanes et al., 2017).[15] In light of the burden of disease from environmental noise, and railway noise in particular, the GDG agreed that the health benefits from a reduction of long-term railway noise exposure (especially during night time) to the recommended values would be significant. Considering possible harms related to adaptation of the recommended values, the GDG noted that reliance on railway transportation has increased in recent years in Europe and is expected to increase further, as an important component of the shift towards a greener economy. At a societal level, an environmental and economic benefit from the use of rail transportation is expected: trains contribute to lower environmental pollution and carbon emission than road transportation. Therefore, there is a need to balance the expected health benefits from reduced continuous railway noise exposure and the overall positive effects on the health of the population from increased reliance on the comparatively environmentally friendly mode of railway transportation. Overall, the GDG agreed that even though fewer people are exposed to railway noise than road traffic noise, it remains a major source of localized noise pollution; therefore, considerable benefits are gained by reducing exposure to railway noise.

When exploring values and preferences, the GDG acknowledged that, in general, people value rail as an alternative and more sustainable transportation method than air or road traffic (EEA, 2016a; 2016b; 2017b). Furthermore, the values and preferences in relation to implementation of the recommendation are expected to vary: those of individuals living in the vicinity of railway tracks are expected to differ from those of the rest of the population not exposed to railway noise on a long-term basis. Economic depreciation of housing and fear of adverse health effects were assumed

[15] These are gap-filled figures based on the reported data and including the situation both within and outside cities, as defined by the END.

to be two main aspects influencing the evaluation of affected individuals. This especially applies to areas where new railway tracks are being built, as this results in considerable change for local inhabitants. Moreover, the GDG acknowledged that preferences might also vary in the policy-making domain across different countries as the implementation of the recommendations would mean a renunciation of the so-called "railway bonus".[16]

On resource use and implementation considerations, the GDG pointed out that no comprehensive cost–benefit analysis for the WHO European Region has yet been conducted, so this assessment is based on informed qualitative expert judgement regarding the feasibility of implementing the recommendation for the majority of the population. The systematic review of environmental noise interventions and their associated impact on health shows that various measures to reduce continuous noise from railway traffic exist, although knowledge about their effectiveness remains limited (Brown & van Kamp, 2017). The GDG noted that the resources needed to implement different measures may vary considerably, as they depend on the situation and the type of intervention required. Implementation of some measures is expected to be most feasible during the development of new railway tracks; such as rail pads, bi-bloc sleepers, small noise barriers and – in extreme cases – tunnels, cuttings or earthwork barriers. Other interventions include acoustic rail grinding, noise barriers built alongside the tracks, construction of quieter locomotives and wagons and replacement of brakes on freight trains. The GDG assumed that most of these solutions could be planned as part of regular maintenance or, for instance, by speeding up fleet modernization and track modernization. Even though not broadly implemented, the solutions mentioned above have already been considered or adopted to reduce noise levels from railway noise exposure. Some EU countries (such as Germany), have programmes to replace old brake blocks from freight trains with newer, quieter ones and to ban all freight trains with old brake blocks from 2020 (Umweltbundesamt, 2017). This illustrates that solutions to achieve recommended noise levels can be implemented at a reasonable cost. Overall, the GDG agreed that the benefit of implementation of the recommendation to minimize the risk of adverse health effects due to railway noise for a majority of the population exceeds the (monetary) resources needed.

In light of the assessment of the contextual factors in addition to the quality of evidence, the recommendation remains strong.

Additional considerations or uncertainties

The GDG acknowledged that the main body of evidence for the recommendations on railway noise for average exposure was based on annoyance studies, conducted mainly in Asia and Europe. Studies are few for other priority health outcomes, and the evidence was generally rated low/very low quality. There is therefore uncertainty about the effects on health outcomes. Nevertheless, as a precautionary approach, a strong recommendation is made for average exposure to L_{den}, as a broad evidence base exists for health effects from exposure to other sources of transportation noise. However, the GDG stressed the importance of further research into health effects due to long-term exposure to railway noise.

Moreover, situational factors should be taken into account when analysing annoyance from railway noise. In particular, ground-borne vibrations are sometimes an additional exposure variable in railway

[16] The "railway bonus" is a correction factor commonly applied in the noise abatement policy domain in recent decades. It subsidizes the noise rating level for railway transportation by a predefined factor (Schuemer & Schuemer-Kohrs, 1991).

noise situations – especially in the case of annoyance – which may be difficult to separate from noise effects. In the set of 11 studies included in the systematic review on railway noise and annoyance, only two explicitly mentioned ground-borne vibrations as an additional source of annoyance.

Overall, the low-carbon, low-polluting nature of railway transport, especially using electric trains, means that rail is favoured over road and air traffic. However, night-time railway traffic on busy lines, including freight traffic, can be a significant source of sleep disturbance. Thus, guideline values should be set to encourage the development of rail traffic in Europe while at the same time giving adequate protection to residents from sleep disturbance.

3.2.3 Summary of the assessment of the strength of the recommendations

Table 25 provides a comprehensive summary of the different dimensions for the assessment of the strength of the railway noise recommendations.

Table 25. Summary of the assessment of the strength of the recommendation

Factors influencing the strength of recommendation	Decision
Quality of evidence	**Average exposure** (L_{den}) *Health effects* • Evidence for a relevant absolute risk of annoyance at **54 dB** L_{den} was rated **moderate quality.** • Evidence for a relevant RR increase of the incidence of hypertension was rated **low quality**. One study met the inclusion criteria but did not find a significant increase. *Interventions* • Evidence that different types of intervention reduce noise annoyance from railways was rated **very low quality**. **Night-time exposure** (L_{night}) *Health effects* • Evidence for a relevant absolute risk of sleep disturbance related to night noise exposure from railways at **44 dB** L_{night} was rated **moderate quality**. *Interventions* • No evidence was available on the effectiveness of interventions to reduce noise exposure and/or sleep disturbance from railway noise.
Balance of benefits versus harms and burdens	Railway noise is a major source of localized pollution. The health benefits of adapting the recommendation outweigh the harms. Nevertheless, it is important to consider the relevance of railways as an environmentally friendly mode of transportation.
Values and preferences	Quiet areas are valued by the population; especially by those affected by continuous noise exposure. Some variability is expected among those directly affected by railway noise and those not affected.
Resource implications	No comprehensive cost–effectiveness-analysis data are available, although a wide range of interventions exists, indicating that measures are both feasible and economically reasonable.
Decisions on recommendation strength	• **Strong** for guideline value for average noise exposure (L_{den}). • **Strong** for guideline value for night noise exposure (L_{night}). • **Strong** for specific interventions to reduce noise exposure.

3.3 Aircraft noise

Recommendations

For average noise exposure, the GDG **strongly** recommends reducing noise levels produced by aircraft below **45 dB** L_{den}, as aircraft noise above this level is associated with adverse health effects.

For night noise exposure, the GDG **strongly** recommends reducing noise levels produced by aircraft during night time below **40 dB** L_{night}, as aircraft noise above this level is associated with adverse effects on sleep.

To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from aircraft in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions the GDG recommends implementing suitable changes in infrastructure.

3.3.1 Rationale for the guideline levels for aircraft noise

The exposure levels were derived in accordance with the prioritization process of critical health outcomes described in section 2.4.3. For each of the outcomes, the exposure level was identified by applying the benchmark, set as relevant risk increase to the corresponding ERF. In the case of exposure to aircraft noise, the process can be summarized as follows (Table 26).

Table 26. Average exposure levels (L_{den}) for priority health outcomes from aircraft noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Incidence of IHD A relevant risk increase from exposure to aircraft noise occurs at 52.6 dB L_{den}. The weighted average of the lowest noise levels measured in the studies was 47 dB L_{den} and the corresponding RR in the meta-analysis was 1.09 per 10 dB.	5% increase of RR	Very low quality
Incidence of hypertension One study met the inclusion criteria. There was no significant increase of risk associated with increased noise exposure in this study.	10% increase of RR	Low quality
Prevalence of highly annoyed population There was an absolute risk of 10% at a noise exposure level of 45.4 dB L_{den}.	10% absolute risk	Moderate quality
Permanent hearing impairment	No increase	No studies met the inclusion criteria
Reading skills and oral comprehension in children A relevant risk increase was found at 55 dB L_{den}.	One-month delay	Moderate quality

Based on the evaluation of evidence on relevant risk increases from the prioritized health outcomes, the GDG set a guideline exposure level of 45.4 dB L_{den} for average exposure to aircraft noise, based on the absolute %HA. It was confident that there was an increased risk for annoyance below this exposure level, but probably no relevant risk increase for other priority health outcomes. In accordance with the defined rounding procedure, the value was rounded to 45 dB L_{den}. As the evidence on the adverse effects of aircraft noise was rated moderate quality, the GDG made the recommendation strong.

Next, the GDG considered the evidence for night noise exposure and its effect on sleep disturbance (Table 27).

Table 27. Night-time exposure levels (L_{night}) for priority health outcomes from aircraft noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Sleep disturbance	3% absolute risk	Moderate quality
11% of participants were highly sleep-disturbed at a noise level of 40 dB L_{night}.		

Based on the evidence of the adverse effects of aircraft noise on sleep disturbance, the GDG defined a guideline exposure level of 40.0 dB L_{night}. It should be stressed that this recommendation for average aircraft noise levels at night far exceeds the benchmark of 3%HSD defined as relevant risk increase, but since no reliable acoustic data below this level were available, the GDG decided not to lower the guideline exposure level further, as an extrapolation of the exposure–response relationship to achieve these values would have been unavoidable. As the evidence was rated moderate quality, the GDG made the recommendation strong.

The GDG also considered the evidence for the effectiveness of interventions. The results showed that changes in infrastructure (opening and/or closing of runways, or flight path rearrangements) can lead to a reduction in aircraft noise exposure, as well as a decline in cognitive impairment in children and a reduction in annoyance. Moreover, examples of best practice already exist for the management of noise from aircraft, so the GDG made a strong recommendation.

3.3.1.1 Other factors influencing the strength of recommendations

Other factors considered in the context of recommendations on aircraft traffic noise included those related to values and preferences, benefits and harms, resource implications, equity, acceptability and feasibility; moreover, nonpriority health outcomes were considered. Ultimately, the assessment of all these factors did not lead to a change in the strength of the recommendations. Further details are provided in section 3.3.2.3.

3.3.2 Detailed overview of the evidence

The following sections provide a detailed overview of the evidence constituting the basis for setting the recommendations on aircraft noise. It is presented and summarized separately for each of the critical health outcomes, and the GDG's judgement of the quality of evidence is indicated (for a detailed overview of the evidence on important health outcomes, see Annex 4). Research into health outcomes and effectiveness of interventions is addressed consecutively.

A comprehensive summary of all evidence considered for each of the critical and important health outcomes can be found in the eight systematic reviews published in the *International Journal of Environmental Research and Public Health* (see section 2.3.2 and Annex 2).

3.3.2.1 Evidence on health outcomes

The key question posed was: in the general population exposed to aircraft noise, what is the exposure–response relationship between exposure to aircraft noise (reported as various noise indicators) and the proportion of people with a validated measure of health outcome, when adjusted for main confounders? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 28 and 29.

Table 28. PICOS/PECCOS scheme of critical health outcomes for exposure to aircraft noise

PECO	Description	
Population	General population	
Exposure	Exposure to high levels of noise produced by aircraft traffic (average/night time)	
Comparison	Exposure to lower levels of noise produced by aircraft traffic (average/night time)	
Outcome(s)	For average noise exposure:	For night noise exposure:
	1. cardiovascular disease	1. effects on sleep
	2. annoyance	
	3. cognitive impairment	
	4. hearing impairment and tinnitus	
	5. adverse birth outcomes	
	6. quality of life, well-being and mental health	
	7. metabolic outcomes	

Table 29 .Summary of findings for health effects from exposure to aircraft noise (L_{den})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)[a]	Quality of evidence
Cardiovascular disease					
L_{den}	Incidence of IHD	RR = 1.09 (95% CI: 1.04–1.15) per 10 dB increase	47 dB	9 619 082[a] (2)	Very low (downgraded for risk of bias; upgraded for dose-response)
L_{den}	Incidence of hypertension	RR = 1.00 (95% CI: 0.77–1.30) per 10 dB increase	N/A	4712 (1)	Low (downgraded for risk of bias and because only one study available)
Annoyance					
L_{den}	%HA	OR = 4.78 (95% CI: 2.27–10.05) per 10 dB increase	33 dB	17 094 (12)	Moderate (downgraded for inconsistency)
Cognitive impairment					
L_{den}	Reading and oral comprehension	1–2-month delay per 5 dB increase	Around 55 dB	(4)	Moderate (downgraded for inconsistency)
Hearing impairment and tinnitus					
L_{den}	Permanent hearing impairment	–	–	–	–

Note: [a] Results are partly derived from population-based studies.

Cardiovascular disease

IHD

No cohort or case-control studies on the relationship between aircraft noise and IHD are available. However, two ecological studies were identified that provide information on the relationship between aircraft noise and incidence (hospital admission) of IHD (Correia et al., 2013; Hansell et al., 2013). These involved a total of 9 619 082 participants, including 158 977 cases. The RR was 1.09 (95% CI: 1.04–1.15) per 10 dB L_{den} increase, and the lowest exposure range was ≤51 dB and <45 dB. Given the weights in the meta-analysis of these two studies, the weighted average starting level was calculated as 47 dB. The evidence was rated very low quality.

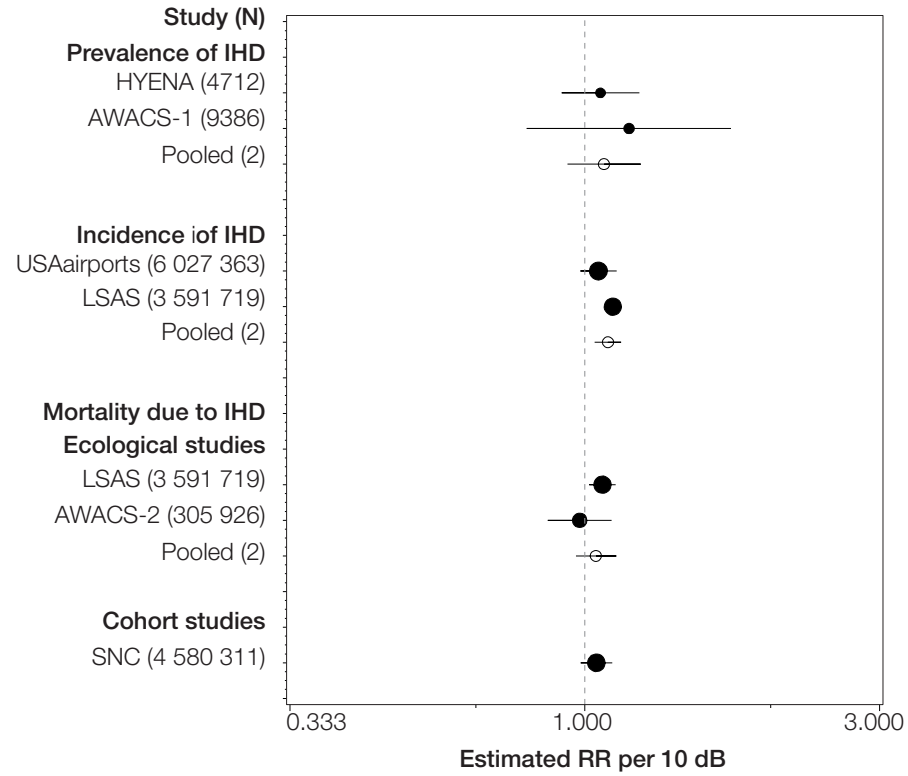
Two cross-sectional studies were identified that assessed the prevalence of IHD in people living in cities located around airports in Europe. The studies involved 14 098 participants, including 340 cases (Babisch et al., 2005b; 2008; 2012a; 2012b; 2013a; Floud et al., 2011; 2013a; 2013b; Jarup et al., 2005; 2008; van Poll et al., 2014). The overall risk was RR = 1.07 (95% CI: 0.94–1.23) per 10 dB L_{den} increase. The evidence was rated low quality.

With regard to the relationship between aircraft noise and mortality due to IHD, one cohort study (Huss et al., 2010) and two ecological studies (Hansell et al., 2013; van Poll et al., 2014) were identified. The cohort study identified 4 580 311 participants, including 15 532 cases, living in Switzerland, and the authors found an RR of 1.04 (95% CI: 0.98–1.11) per 10 dB L_{den} increase in noise. The evidence was rated low quality. The two ecological studies identified a total of 3 897 645

participants, including 26 066 cases in the Netherlands and the United Kingdom. The overall RR was 1.04 (95% CI: 0.97–1.12) per 10 dB L_{den} increase in noise, and the evidence was rated very low quality.

Fig. 10 summarizes the results for the relationship between aircraft noise and different measures of IHD.

Fig. 10. The association between exposure to aircraft noise (L_{den}) and IHD



Notes: The dotted vertical line corresponds to no effect of exposure to aircraft noise. The black circles correspond to the estimated RR per 10 dB and 95% CI. The white circles represent the pooled random effect estimates and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Hypertension

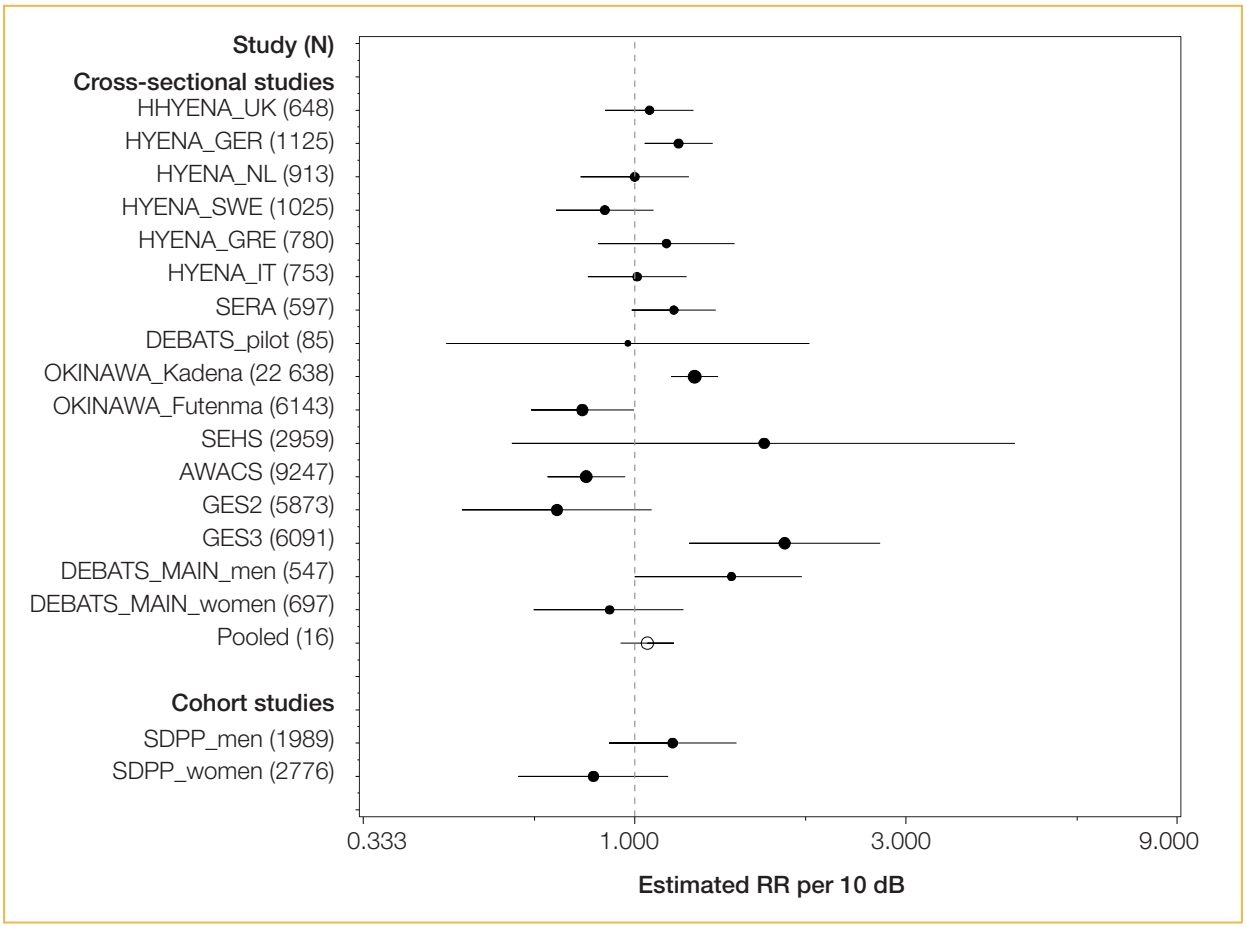
One cohort study was identified that assessed the relationship between aircraft noise and hypertension in people living in Sweden (Bluhm et al., 2004; 2009; Eriksson et al., 2007; 2010). The study involved 4712 participants, including 1346 cases. The authors found a nonstatistically significant effect size of RR = 1.00 (95% CI: 0.77–1.30) per 10 dB L_{den} increase. This evidence was rated moderate quality.

Furthermore, nine cross-sectional studies assessed the prevalence of hypertension in 60 121 participants, including 9487 cases (Ancona et al., 2010; Babisch et al., 2005b; 2008; 2012a; 2012b; 2013a; Breugelmans et al., 2004; Evrard et al., 2013; 2015; Houthuijs & van Wiechen, 2006; Jarup

et al., 2005; 2008; Matsui, 2013; Matsui et al., 2001; 2004; Rosenlund et al., 2001; van Kamp et al., 2006; van Poll et al., 2014). The overall RR was 1.05 (95% CI: 0.95–1.17) per 10 dB L_{den} increase, with inconsistency across studies. The evidence was rated low quality.

Fig. 11 summarizes the results for both prevalence and incidence of hypertension.

Fig. 11. The association between exposure to aircraft noise (L_{den}) and hypertension in cross-sectional and cohort studies



Notes: The dotted vertical line corresponds to no effect of aircraft noise exposure. The black dots correspond to the estimated RR per 10 dB and 95% CI. The white circle represents the pooled summary estimate and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Stroke

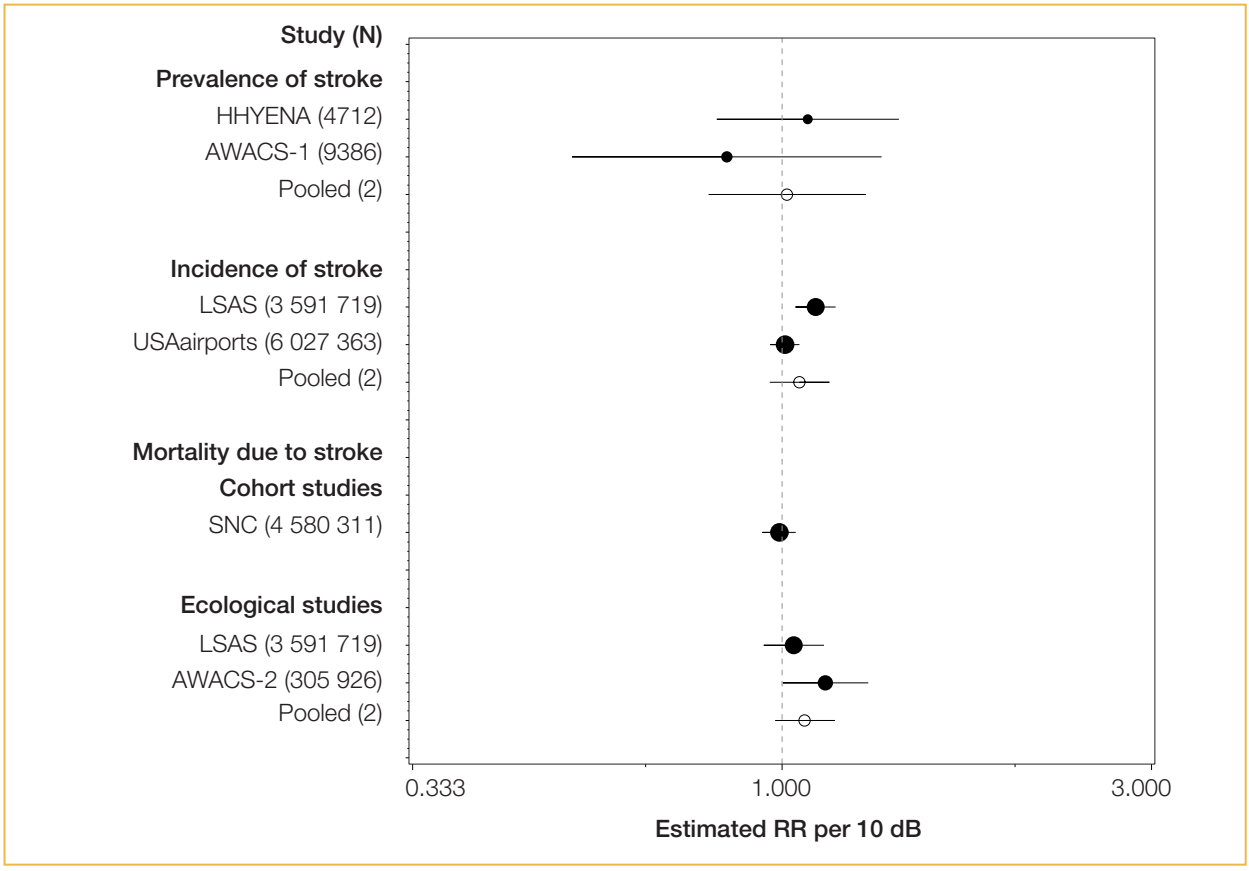
No cohort or case-control studies on the relationship between aircraft noise and incidence (hospital admission) of stroke were available, but two ecological studies were conducted in cities around airports in the United Kingdom and United States of America, involving 9 619 082 participants, including 97 949 cases (Correia et al., 2013; Hansell et al., 2013). An overall RR of 1.05 (95% CI: 0.96–1.15) per 10 dB L_{den} increase in noise was found. The evidence was rated very low quality.

Two cross-sectional studies were identified that assessed the prevalence of stroke in 14 098 participants, including 151 cases (Babisch et al., 2005b; 2008; 2012a; 2012b; 2013a; Floud et al., 2011; 2013a; 2013b; Jarup et al., 2005; 2008; van Poll et al., 2014). The overall RR was 1.02 (95% CI: 0.80–1.28) per 10 dB L_{den} increase. The evidence was rated very low quality.

On the relationship between aircraft noise and mortality due to stroke, one cohort study (Huss et al., 2010) and two ecological studies (Hansell et al., 2013; van Poll et al., 2014) were identified. The cohort study identified 4 580 311 participants, including 25 231 cases, living in Switzerland; the authors found an RR of 0.99 (95% CI: 0.94–1.04) per 10 dB L_{den} increase in noise. The overall evidence was rated moderate quality. The two ecological studies identified a total of 3 897 645 participants, including 12 086 cases, in the Netherlands and the United Kingdom. The overall RR was 1.07 (95% CI: 0.98–1.17) per 10 dB L_{den} increase in noise. The evidence was rated very low quality.

Fig. 12 summarizes the results for the relationship between aircraft noise and different measures of stroke.

Fig. 12. The association between exposure to aircraft noise (L_{den}) and stroke



Notes: The dotted vertical line corresponds to no effect of exposure to aircraft noise. The black dots correspond to the estimated RR per 10 dB and 95% CI. The white circle represents the summary estimate and 95% CI.
For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

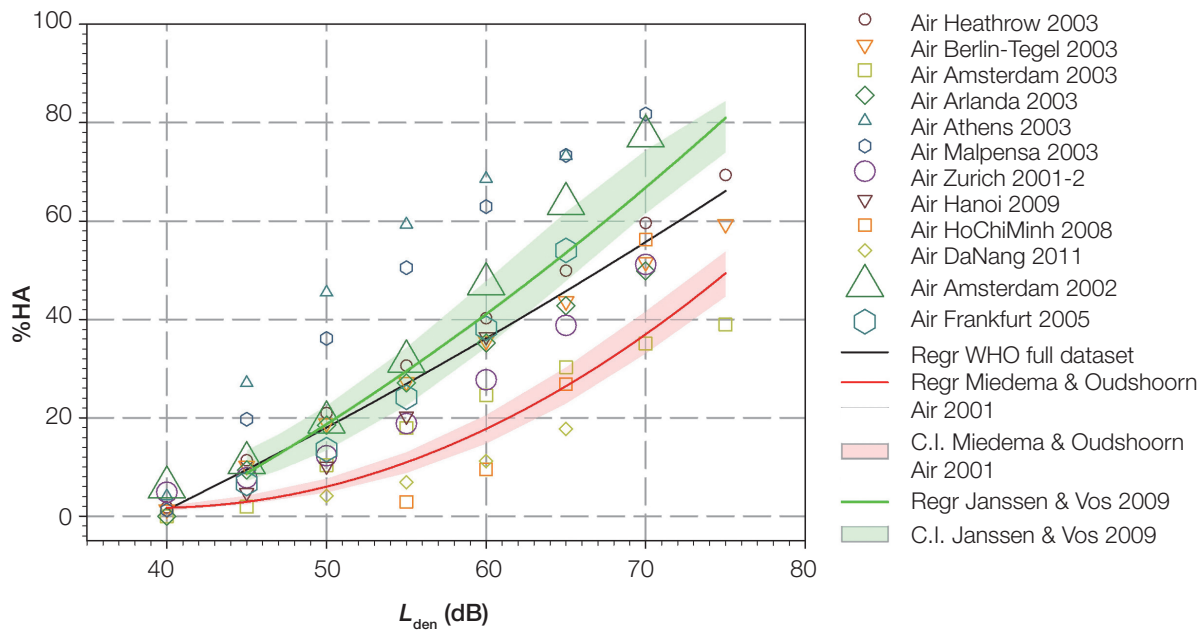
Children's blood pressure

For the association between aircraft noise and blood pressure in children, two cross-sectional studies were conducted in Australia, the Netherlands and the United Kingdom, including a total of 2013 participants (Clark et al., 2012; Morrell et al., 1998; 2000; van Kempen et al., 2006). The change in both systolic and diastolic blood pressure was assessed, in residential and/or educational settings. There was serious inconsistency in the results and therefore no overall estimate of the effect was developed. The evidence was rated very low quality.

Annoyance

A vast amount of evidence proves the association between aircraft noise and annoyance. In total, 12 aircraft noise studies were identified that were used to model ERFs of the relationship between L_{den} and %HA (Babisch et al., 2009; Bartels et al., 2013; Breugelmans et al., 2004; Brink et al., 2008; Gelderblom et al., 2014; Nguyen et al., 2011; 2012a; 2012b; Sato & Yano, 2011; Schreckenberg & Meis, 2007). These include data from 17 094 study participants. The estimated data points of each of the studies are plotted in Fig. 13, alongside an aggregated ERF including the data from all the individual studies (see the black line for "Regr WHO full dataset"). The lowest category of noise exposure considered in any of the studies, and hence included in the systematic review, is 40 dB, corresponding to approximately 1.2%HA. The benchmark level of 10%HA is reached at approximately 45 dB L_{den} (see Fig. 13).

Fig. 13. Scatterplot and quadratic regression of the relationship between aircraft noise (L_{den}) and annoyance (%HA)



Notes: ERFs by Miedema & Oudshoorn (2001, red), and Janssen & Vos (2009, green) are added for comparison. There is no indication of 95% CIs of the WHO dataset curve, as a weighting based on the total number of participants for each 5 dB L_{den} sound class could not be calculated; weighting based on all participants of all sound classes proved to be unsuitable. The range of data included is illustrated by the distribution of data points. For further details on the studies included in the figure please refer to the systematic review on environmental noise and annoyance (Guski et al., 2017).

Table 30 shows the %HA in relation to exposure to aircraft traffic noise. It is based on the regression equation %HA = –50.9693 + 1.0168 × L_{den} + 0.0072 × L_{den}^2 derived from the systematic review (Guski et al., 2017). As the majority of the studies are cross-sectional, the evidence was rated moderate quality.

The general quality of the evidence was further substantiated with the help of additional statistical analyses that apply classical health outcome measures to estimate noise annoyance. When comparing aircraft noise exposure at 50 dB and 60 dB, the analyses revealed evidence rated high quality for an association between aircraft noise and %HA for an increase per 10 dB (OR = 3.40; 95% CI: 2.42–4.80). Moreover, there was evidence rated high quality for the increase of %HA per 10 dB increase in sound exposure, when data on all sound classes were included (OR = 4.78; 95% CI: 2.27–10.05).

Table 30. The association between exposure to aircraft noise (L_{den}) and annoyance (%HA)

L_{den} (dB)	%HA
40	1.2
45	9.4
50	17.9
55	26.7
60	36.0
65	45.5
70	55.5

Cognitive impairment

Evidence rated moderate quality was available for an association between aircraft noise and reading and oral comprehension, assessed by standardized tests. This is based on a narrative review of 14 studies that examined aircraft noise exposure effects on reading and oral comprehension (Clark et al., 2006; 2012; 2013; Evans & Maxwell, 1997; Haines et al., 2001a; 2001b; 2001c; Hygge et al., 2002; Klatte et al., 2014; Matsui et al., 2004; Seabi et al., 2012; 2013; Stansfeld et al., 2005; 2010). Of these studies, 10 were cross-sectional, and only four had a longitudinal and/or intervention design (Clark et al., 2013; Haines et al., 2001c; Hygge et al., 2002; Seabi et al., 2013). Most of the studies (10 of 14) demonstrated a statistically significant association or at least demonstrated a trend between higher aircraft noise exposure and poorer reading comprehension.

This relationship is supported by evidence on other health outcome measures related to cognition. Evidence rated moderate quality was available for an association between aircraft noise and children with poorer performance on standardized assessment tests (Eagan et al., 2004; FICAN, 2007; Green et al., 1982; Sharp et al., 2014). There was also evidence rated moderate quality on aircraft noise being associated with children having poorer long-term memory (Haines et al., 2001b). No studies examined the effects on short-term memory.

However, there was no substantial effect (evidence rated low quality) of aircraft noise on children's attention (Haines et al., 2001a; Hygge et al., 2002; Matsui et al., 2004; Stansfeld et al., 2005; 2010), or on executive function (working memory) (evidence rated very low quality), with studies consistently suggesting no association for aircraft noise (Clark et al., 2012; Haines et al., 2001a;

Haines et al., 2001b; Klatte et al., 2014; Matheson et al., 2010; Stansfeld et al., 2005; 2010; van Kempen et al., 2010; 2012).

Hearing impairment and tinnitus

No studies were found, and therefore no evidence was available on the association between aircraft noise and hearing impairment and tinnitus.

Sleep disturbance

For aircraft noise and self-reported sleep outcomes, six studies were identified that included a total of 6371 participants (Nguyen et al., 2009; 2010; 2011; 2012c; 2015; Schreckenberg et al., 2009; Yano et al., 2015). The majority of studies were cross-sectional by design and were conducted in otherwise healthy adults. The model was based on outdoor L_{night} levels between 40 dB and 65 dB only; the lower limit of 40 dB was set because of inaccuracies in predicting lower noise levels (Table 31).

Table 31. Summary of findings for health effects from exposure to aircraft noise (L_{night})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)	Quality of evidence
Effects on sleep					
L_{night}	%HSD	OR: 1.94 (95% CI: 1.61–2.33) per 10 dB increase	35 dB	6371 (6)	Moderate (downgraded for study limitations, inconsistency; upgraded for dose-response, magnitude of effect)

The range of noise exposure reported in studies was 37.5–62.5 dB. Over 11% (95% CI: 4.72–17.81) of the population was characterized as highly sleep-disturbed at L_{night} levels of 40 dB. The %HSD at other, higher levels of aircraft noise is presented in Table 27. The table is derived from the regression model in the systematic review specified as $\%HSD = 16.79–0.9293 \times L_{night} + 0.0198 \times L_{night}^2$. The health outcome was measured in the studies by self-reporting, focusing on questions asking about awakenings from sleep, the process of falling asleep and/or sleep disturbance, where the question referred specifically to how noise affects sleep. The same relationship between aircraft noise and reporting being sleep-disturbed (all questions combined) can also be expressed as an OR of 1.94 (95% CI: 1.61–2.33) per 10 dB increase in noise. This evidence was rated moderate quality.

Table 32. The association between exposure to aircraft noise (L_{night}) and sleep disturbance (%HSD)

L_{night}	%HSD	95% CI
40	11.3	4.72–17.81
45	15.0	6.95–23.08
50	19.7	9.87–29.60
55	25.5	13.57–37.41
60	32.3	18.15–46.36
65	40.0	23.65–56.05

Additional analyses were included in the systematic review and provided supporting evidence on the association between aircraft noise and sleep. When the noise source was not specified in the survey question, the relationship between aircraft noise and self-reported sleep outcomes was still positive, although no longer statistically significant (OR: 1.17 (95% CI: 0.54–2.53) per 10 dB increase) (Brink, 2011). This evidence was rated very low quality.

Further, there was evidence rated moderate quality for an association between aircraft noise and polysomnography-measured outcomes (probability of additional awakenings), with an OR of 1.35 (95% CI: 1.22–1.50) per 10 dB increase in indoor $L_{AS,max}$ (Basner et al., 2006). Evidence rated low quality was also available for an association between aircraft noise and motility-measured sleep outcomes in adults (Passchier-Vermeer et al., 2002).

3.3.2.2 Evidence on interventions

The following section summarizes the evidence underlying the recommendation on the effectiveness of interventions for aircraft noise exposure. The key question posed was: in the general population exposed to aircraft noise, are interventions effective in reducing exposure to and/or health outcomes from aircraft noise? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 33 and 34.

Seven studies examining different types of interventions on aircraft noise met the inclusion criteria to become part of the evidence base of the systematic review. Six of these investigated infrastructure interventions (Breugelmans et al., 2007; Brink et al., 2008; Fidell et al., 2002; Hygge et al., 2002), and one assessed a path intervention (Asensio et al., 2014). The majority of studies focused on annoyance as a health outcome, but two also included effects on sleep and one investigated the effects of path interventions on cognitive development in children.

Table 33. PICOS/PECCOS scheme of the effectiveness of interventions for exposure to aircraft noise

PICO	Description	
Population	**General population**	
Intervention(s)	The interventions can be defined as: (a) a measure that aims to change noise exposure and associated health effects; (b) a measure that aims to change noise exposure, with no particular evaluation of the impact on health; or (c) a measure designed to reduce health effects, but that may not include a reduction in noise exposure.	
Comparison	**No intervention**	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 34. Summary of findings for aircraft noise interventions by health outcome

Type of intervention	Number of participants (studies)	Effect of intervention	Quality of evidence
Annoyance			
Type B – path interventions (retrofitting dwellings close to airports with acoustic insulation)	689 (1)	• Change in noise levels was not reported. • The study found a drop in annoyance following the insulation intervention	Very low (downgraded for study limitations, inconsistency, precision)
Type C – changes in infrastructure (opening and/or closing of runways, or flight path rearrangements)	2101 (3)	• There was a wide range of changes in noise levels (from –12 dB to +13.7 dB; most between ±1 dB and 2 dB; different noise indicators used). • All studies found changes in annoyance outcomes as a result of the intervention.	Moderate (downgraded for study limitations; upgraded for dose-response)
Sleep disturbance			
Type C – changes in infrastructure (flight path changes)	1707 (2)	• Changes in noise levels were mostly between ±1 dB and 2 dB. • Both studies found changes in sleep disturbance outcomes as a result of the intervention.	Low (downgraded for study limitations)
Cognitive development of children			
Type C – changes in infrastructure (opening and/or closing of runways, or flight path rearrangements)	326 (1)	• Changes in noise levels of +9 dB at the new airport and of –14 dB at the old airport were reported. • The study found various cognitive effects on children (for both the reduction and the increase in exposure). Effects disappeared when the old airport closed, emerging after the new airport opened.	Moderate (downgraded for inconsistency)

The largest body of research concentrated on the opening and closing of runways, leading to subsequent changes in flight paths (Breugelmans et al., 2007; Brink et al., 2008; Fidell et al., 2002). It showed that changes in noise exposure as a consequence of rearrangement of flight paths, step changes or increase or removal of over-flights resulted in statistically significant changes of the annoyance ratings of residents living in the vicinity of airports. The studies investigated both increases and reductions in exposure. Moreover, all the studies provided evidence that the change in response to noise exposure was an excess response to the intervention. As all the studies either adjusted for confounding or ruled out confounding by design, and the risk of bias was high in two studies but low in one, the evidence was rated moderate quality.

Two of these studies also investigated the effects of interventions on sleep disturbance. The results indicated that the percentage of sleep disturbance changed in association with the change in noise exposure caused by flight path adaptations (Breugelmans et al., 2007; Fidell et al., 2002). Both studies adjusted for confounding, but the risk of bias was assessed as high. Thus, the evidence was rated low quality.

One study examined the impact of rearranging flight paths on the cognitive effects on children (Hygge et al., 2002), showing various effects (for both the reduction and the increase in exposure).

The study ruled out confounding by study design and the risk of bias was assessed as low. The evidence was therefore rated moderate quality.

Alongside infrastructure interventions, a Spanish study presented evidence on path interventions (Asensio et al., 2014), showing a drop in annoyance following an insulation intervention. The study did not control for confounding and the risk of bias was assessed as high. The evidence was therefore rated very low quality.

3.3.2.3 Consideration of additional contextual factors

As the foregoing overview has shown, substantial evidence about the adverse health effects of long-term exposure to aircraft noise exists. Based on the quality of the available evidence, the GDG set the strength of the recommendation of aircraft noise at strong. As a second step, it qualitatively assessed contextual factors to explore whether other considerations could have a relevant impact on the recommendation strength. These considerations mainly concerned the balance of harms and benefits, values and preferences, equity, and resource use and implementation.

When assessing the balance of harms and benefits from implementing the recommendations on aircraft exposure, the GDG acknowledged that the number of people affected was lower than for road traffic or railway noise, since aircraft noise only affects the areas surrounding airports and under flight paths. Data from the EEA show that the estimated number of people in Europe exposed to L_{den} levels above 55 dB and L_{night} levels above 50 dB is 3 million and 1.2 million, respectively (Blanes et al., 2017).[17] Nevertheless, it remains a major source of localized noise pollution and has been predicted to increase (EASA et al., 2016). Furthermore, aircraft noise is regarded as more annoying than the other sources of transportation noise (Schreckenberg et al., 2015; Miedema & Oudshoorn, 2001); it is therefore associated with a significant burden on public health, and the GDG expects substantial health benefits for the population to evolve from implementing the recommendations to reduce exposure to aircraft traffic noise. Furthermore, the GDG noted that, depending on the intervention measure implemented (such as a night flight ban), additional health benefits could evolve, resulting from a simultaneous reduction in air pollution (EC, 2016a). The GDG also acknowledged that intervention measures like night flight bans might also reduce carbon emission, thereby positively influencing the shift towards a greener and more sustainable economy. Possible harms in relation to the applied noise abatement strategy, on the other hand, could include effects on the transportation of goods, as well as individual mobility of the population. Both could have impacts on local, national and international economies. Overall, the GDG estimated that the benefits gained from minimizing adverse health effects due to aircraft noise exposure outweigh the possible (economic) harms.

Considering values and preferences, the GDG noted that negative attitudes towards aircraft noise are especially prevalent in affected individuals who can see and hear aircraft from their house, or who fear that living in proximity of airports will have an impact on their health (Schreckenberg et al., 2015) or property value (economic loss) (Bristow et al., 2014). A lack of trust in the airport and government authorities can enhance these negative attitudes towards airports and aircraft noise (Borsky, 1979; Schreckenberg, 2017). Furthermore, the GDG recognized that values and preferences of individuals living in the vicinity of different airports may vary, as the infrastructural characteristics

[17] These are gap-filled figures based on the reported data and including the situation both within and outside cities, as defined by the END.

of airports have a significant effect on the evaluation of residents. Airports with a stable number of aircraft movements in the near past and no intention to change the number in the future can give rise to a different evaluation of values and preferences than airports with relatively sustained increases in the number of aircraft movements. This can result from the fact that opening new runways or increasing the number of flights usually means considerable change in the environment for inhabitants of the affected area. It has been postulated that the change of exposure itself may be an annoying factor, and this may explain why aircraft noise annoyance is generally higher than that for other sources of transportation noise at a comparable noise level (Brown & van Kamp, 2009). The GDG acknowledged that, in general, air travel is an important means of transportation relevant for businesses, the public and the economy. In Europe, aviation is projected to be the fastest-growing sector from passenger transport demand, by 2050 (EEA, 2016a). The general population tends to value the convenience of travel by air. Moreover, the GDG pointed out that exposure to aircraft noise is not equally distributed throughout society. The preferences of people living in the vicinity of airports are expected to differ from those of the general population that does not experience the same noise burden. This might facilitate variance in the values and preference of the population, as those benefiting from the services and revenues generated by an airport may regard noise reduction measures as an additional, unnecessary extra cost, while those living around an airport and affected by aircraft noise may be in favour of noise reductions, since this concerns their health and well-being. Despite these differences, however, the GDG was confident that a majority of the population would value the minimization of adverse health effects and therefor welcome the implementation of the recommendations.

Regarding the dimension of equity, the GDG highlighted that the risk of exposure to aircraft noise is not equally distributed throughout society. Members of society with a lower socioeconomic status and other disadvantaged groups often live in more polluted and louder areas, including in close proximity to airports (EC, 2016a). In addition to the increased risk of exposure to environmental noise, socioeconomic factors are also associated with increased vulnerability and poorer coping capacities (Karpati et al., 2002).

With resource use and implementation considerations, the GDG acknowledged that the economic evaluation of the health impacts of environmental noise is most elaborate and extensive for aircraft noise (Berry & Sanchez, 2014). Nevertheless, no comprehensive cost–benefit analysis for the WHO European Region yet exists, so this assessment is based on informed qualitative expert judgement regarding the feasibility of implementing the recommendation for the majority of the population. The systematic review of interventions and their associated impact on environmental noise and health shows that various measures to reduce continuous noise from aircraft exist. Moreover, the quality of the evidence was judged to be moderate (Brown & van Kamp, 2017). The GDG noted that the resources needed to implement different intervention measures may vary considerably, because they depend on the situation and the type of intervention required. The distribution of costs also differs from that for other modes of transportation, since exposure to aircraft noise is localized in a more agglomerated way, and overall the population affected is smaller compared to other modes of transportation. The GDG furthermore recognized that multiple cost-effective intervention strategies exist (EC, 2016b). Prohibition or discouragement strategies against citizens moving to the direct proximity of airports, for example, can be implemented in the context of urban planning. Likewise, diverting flight paths above less-populated areas can lead to a reduction in exposure. In principle,

such intervention measures do not involve any direct costs, although safety concerns may limit the feasibility of these strategies. Passive noise abatement measures like the installation of soundproof windows at the dwelling were also regarded as feasible and economically reasonable by the GDG, as these are implemented at several airports already. In relation to active abatement measures, the GDG acknowledged the "balanced approach" elaborated by International Civil Aviation Organization, which states that noise reduction should take place first at the source. As indicated by the Clean Sky Programme, this could, for example, entail shifting towards the introduction of new aircraft. This broad European research programme estimates that, depending on type, the shift to newly produced aircraft could lead to a reduction of approximately 55–79% of the area affected by aircraft noise, and consequently the population exposed. As this solution has been put forward by the aviation sector, it is considered feasible. Overall, this indicates that solutions to achieve recommended noise levels can be implemented and at reasonable costs. The GDG agreed that implementation of the recommendation to minimize the risk of adverse health effects due to aircraft noise for a majority of the population would require a reasonable amount of (monetary) resources. It noted, however, that the feasibility of implementing the measures could be hindered by the fact that costs and benefits are not equally distributed. In most cases, the health benefits citizens gain from interventions that reduce aircraft exposure are borne by private companies and public authorities.

In light of the assessment of the contextual factors in addition to the quality of evidence, the recommendation remains strong.

Other nonpriority adverse health outcomes

Although not a priority health outcome and coming from a single study, the GDG noted the evidence rated moderate quality for the statistically significant association between aircraft noise and the change in waist circumference (Eriksson et al., 2014). The range of noise levels in the study identified was 48 to 65 dB L_{den}, and therefore the recommendation would also be protective enough for this health outcome.

In the context of aircraft noise, when considering the impacts of exposure on cognitive impairment in children, these guideline recommendations also apply particularly to the school setting. Noise exposure at primary school and at home is often highly correlated; however, the evidence base considered comes mainly from studies designed around sampling at school and not residences.

Additional considerations or uncertainties

There is additional uncertainty when characterizing exposure using the acoustical description of aircraft noise by means of L_{den} or L_{night}. Use of these average noise indicators may limit the ability to observe associations between exposure to aircraft noise and some health outcomes (such as awakening reactions); as such, noise indicators based on the number of events (such as the frequency distribution of $L_{A,max}$) may be better suited. However, such indicators are not widely used.

The GDG acknowledged that the guideline recommendation for L_{night} may not be fully protective of health, as it implies that around 11% (95% CI: 4.72–17.81) of the population may be characterized as highly sleep-disturbed at the recommended L_{night} level. This is higher than the 3% absolute risk considered for setting the guideline level. However, the high calculation uncertainty in predicting noise levels lower than 40 dB prevented the GDG from recommending a lower level. Furthermore,

lower levels would probably require a ban on night or early morning flights altogether, which is not feasible in many situations, given that the general population tends to value the convenience of air travel.

3.3.3 Summary of the assessment of the strength of recommendation

Table 35 provides a comprehensive summary of the different dimensions for the assessment of the strength of the aircraft noise recommendations.

Table 35. Summary of the assessment of the strength of the recommendation

Factors influencing the strength of recommendation	Decision
Quality of evidence	**Average exposure (L_{den})** *Health effects* • Evidence for a relevant RR increase of the incidence of IHD at **52 dB** L_{den} was rated **very low quality.** • Evidence for a relevant RR increase of the incidence of hypertension was rated **low quality**. • Evidence for a relevant absolute risk of annoyance at **45 dB** L_{den} was rated **moderate quality**. • Evidence for a relevant RR increase of impaired reading and oral comprehension at **55 dB** L_{den} was rated **moderate quality**. *Interventions* • Evidence on effectiveness of interventions to reduce noise exposure and/or health outcomes from aircraft noise was of varying quality. **Night-time exposure (L_{night})** *Health effects* • Evidence for a relevant absolute risk of sleep disturbance related to night noise exposure from aircraft at **40 dB** L_{night} was rated **moderate quality**. *Interventions* • Evidence on effectiveness of changes in infrastructure (flight path changes) to reduce sleep disturbance from aircraft noise was rated **low quality**.
Balance of benefits versus harms and burdens	Aircraft noise is a major source of localized noise pollution. The health benefits of adapting the recommendations are expected to outweigh the harms.
Values and preferences	Quiet areas are valued by the population, especially by those affected by continuous aircraft noise exposure. Some variability is expected among those directly affected by aircraft noise and those not affected.
Equity	Risk of exposure to aircraft noise is not equally distributed.
Resource implications	No comprehensive cost–effectiveness analysis data are available; nevertheless, a wide variety of interventions exist (some at very low cost), indicating that measures are both feasible and economically reasonable.
Decisions on recommendation strength	• **Strong** for guideline value for average noise exposure (L_{den}) • **Strong** for guideline value for night noise exposure (L_{night}) • **Strong** for specific interventions to reduce noise exposure

3.4 Wind turbine noise

Recommendations

For average noise exposure, the GDG **conditionally** recommends reducing noise levels produced by wind turbines below **45 dB** L_{den}, as wind turbine noise above this level is associated with adverse health effects.

To reduce health effects, the GDG **conditionally** recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another.

3.4.1 Rationale for the guideline levels for wind turbine noise

The exposure levels were derived in accordance with the prioritizing process of critical health outcomes described in section 2.4.3. For each of the outcomes, the exposure level was identified by applying the benchmark, set as relevant risk increase to the corresponding ERF. In the case of exposure to wind turbine noise, the process can be summarized as follows (Table 36).

Table 36. Average exposure levels (L_{den}) for priority health outcomes from wind turbine noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Incidence of IHD Incidence of IHD could not be used to assess the exposure level.	5% increase of RR	No studies were available
Incidence of hypertension Incidence of hypertension could not be used to assess the exposure level.	10% increase of RR	No studies were available
Prevalence of highly annoyed population Four studies were available. An exposure–response curve of the four studies revealed an absolute risk of 10%HA (outdoors) at a noise exposure level of 45 dB L_{den}.	10% absolute risk	Low quality
Permanent hearing impairment	No increase	No studies were available
Reading skills and oral comprehension in children	One-month delay	No studies were available

In accordance with the prioritization process, the GDG set a guideline exposure level of 45.0 dB L_{den} for average exposure, based on the relevant increase of the absolute %HA. The GDG stressed that there might be an increased risk for annoyance below this noise exposure level, but it could not state whether there was an increased risk for the other health outcomes below this level owing to a lack of evidence. As the evidence on the adverse effects of wind turbine noise was rated low quality, the GDG made the recommendation conditional.

Next, the GDG considered the evidence for night noise exposure to wind turbine noise and its effect on sleep disturbance (Table 37).

Table 37. Night-time exposure levels (L_{night}) for priority health outcomes from wind turbine noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Sleep disturbance Six studies were available; they did not reveal consistent results about effects of wind turbine noise on sleep.	3% absolute risk	Low quality

Based on the low quantity and heterogeneous nature of the evidence, the GDG was not able to formulate a recommendation addressing sleep disturbance due to wind turbine noise at night time.

The GDG also looked for evidence about the effectiveness of interventions for wind turbine noise exposure. Owing to a lack of research, however, no studies were available on existing interventions and associated costs to reduce wind turbine noise.

Based on this assessment, the GDG therefore provided a conditional recommendation for average noise exposure (L_{den}) to wind turbines and a conditional recommendation for the implementation of suitable measures to reduce noise exposure. No recommendation about a preferred type of intervention could be formulated; nor could a recommendation be made for an exposure level for night noise exposure (L_{night}), as studies were not consistent and in general did not provide evidence for an effect on sleep.

3.4.1.1 Other factors influencing the strength of recommendation

Other factors considered in the context of recommendations on wind turbine noise included those related to values and preferences, benefits and harms, resource implications, equity, acceptability and feasibility. Ultimately, the assessment of all these factors did not lead to a change in the strength of recommendation, although it informed the development of a conditional recommendation on the intervention measures. Further details are provided in section 3.4.2.3.

3.4.2 Detailed overview of the evidence

The following sections provide a detailed overview of the evidence constituting the basis for setting the recommendations on wind turbine noise. It is presented and summarized separately for each of the critical health outcomes, and the GDG's judgement of the quality of evidence is indicated (for a detailed overview of the evidence on important health outcomes, see Annex 4). Research into health outcomes and effectiveness of intervention is addressed consecutively.

A comprehensive summary of all evidence considered for each of the critical and important health outcomes can be found in the eight systematic reviews published in the *International Journal of Environmental Research and Public Health* (see section 2.3.2 and Annex 2).

It should be noted that, due to the time stamp of the systematic reviews, some more recent studies were not included in the analysis. This relates in particular to several findings of the Wind Turbine Noise and Health Study conducted by Health Canada (Michaud, 2015). Further, some studies were omitted, as they did not meet the inclusion criteria, including, for instance, studies using distance to the wind turbine instead of noise exposure to investigate health effects. The justification for including and excluding studies is given in the systematic reviews (Basner & McGuire, 2018; Brown et al.,

2017; Clark & Paunovic, 2018; in press; Guski et al., 2017; Niewenhuijsen et al.,2017; Śliwińska-Kowalska & Zaborowski, 2017; van Kempen et al., 2018; see Annex 2 for further details).

3.4.2.1 Evidence on health outcomes

The key question posed was: in the general population exposed to wind turbine noise, what is the exposure–response relationship between exposure to wind turbine noise (reported as various noise indicators) and the proportion of people with a validated measure of health outcome, when adjusted for main confounders? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 38 and 39.

Table 38. PICOS/PECCOS scheme of critical health outcomes for exposure to wind turbine noise

PECO	Description	
Population	General population	
Exposure	Exposure to high levels of noise produced by wind turbines (average/night time)	
Comparison	Exposure to lower levels of noise produced by wind turbines (average/night time)	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 39. Summary of findings for health effects from exposure to wind turbine noise (L_{den})

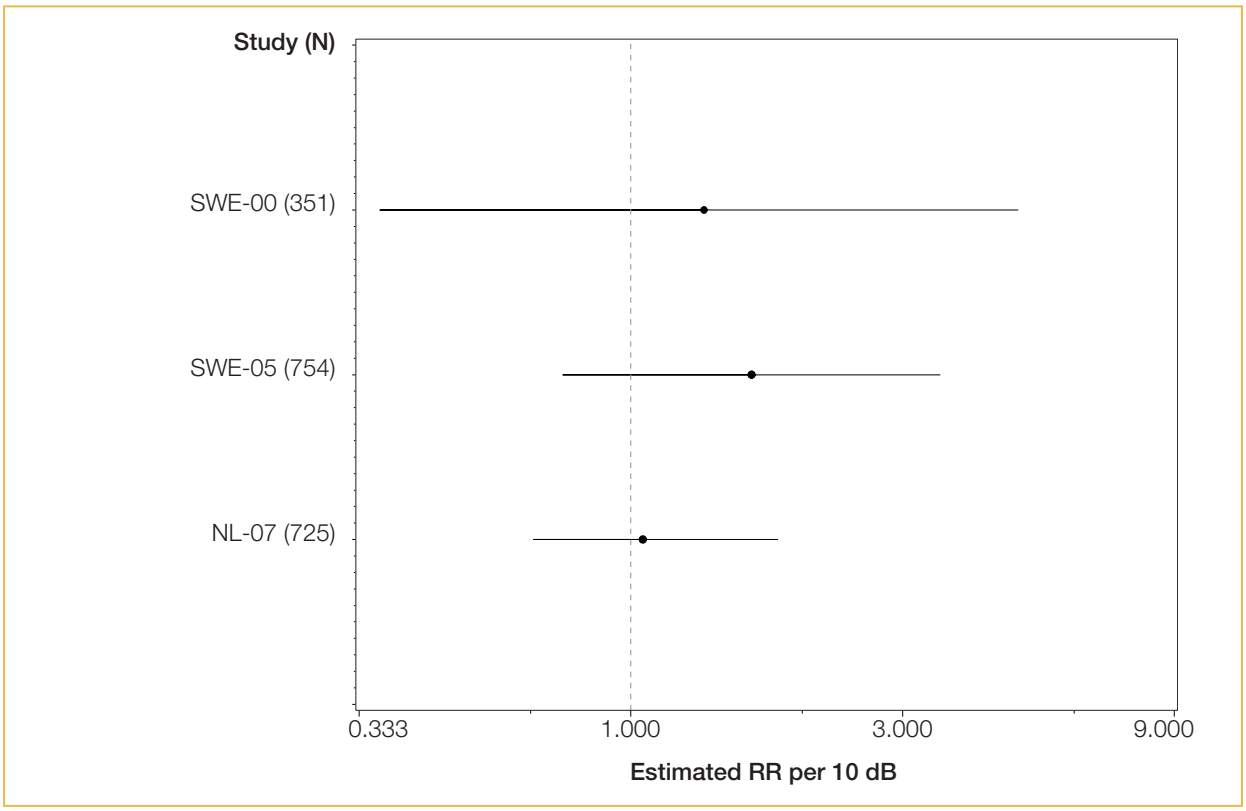
Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)	Quality of evidence
Cardiovascular disease					
L_{den}	Incidence of IHD	–	–	–	–
L_{den}	Incidence of hypertension	–	–	–	–
Annoyance					
L_{den}	%HA	Not able to pool because of heterogeneity	30 dB	2481 (4)	Low (downgraded for inconsistency and imprecision)
Cognitive impairment					
L_{den}	Reading and oral comprehension	–	–	–	–
Hearing impairment and tinnitus					
L_{den}	Permanent hearing impairment	–	–	–	–

Cardiovascular disease

For the relationship between wind turbine noise and prevalence of hypertension, three cross-sectional studies were identified, with a total of 1830 participants (van den Berg et al., 2008; Pedersen, 2011; Pedersen & Larsman, 2008; Pedersen & Persson Waye, 2004; 2007). The number of cases was not reported. All studies found a positive association between exposure to wind turbine noise and the prevalence of hypertension, but none was statistically significant. The lowest levels in studies were either <30 or <32.5 L_{den}. No meta-analysis was performed, since too many parameters were unknown and/or unclear. Due to very serious risk of bias and imprecision in the results, this evidence was rated very low quality (see Fig. 14).

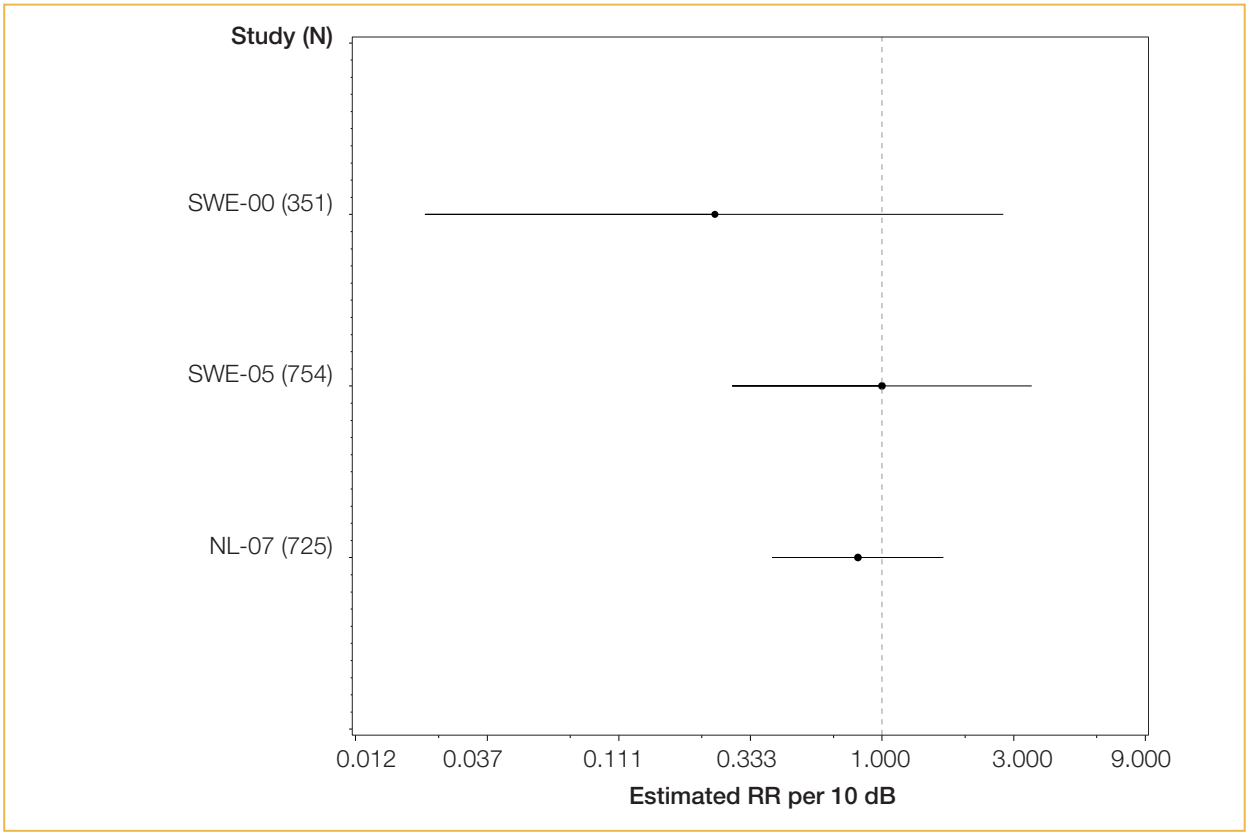
The same studies also looked at exposure to wind turbine noise and self-reported cardiovascular disease, but none found an association. No evidence was available for other measures of cardiovascular disease. As a result, only evidence rated very low quality was available for no considerable effect of audible noise (greater than 20 Hz) from wind turbines or wind farms on self-reported cardiovascular disease (see Fig. 15).

Fig. 14. The association between exposure to wind turbine noise (sound pressure level in dB) and hypertension



Notes: The dotted vertical line corresponds to no effect of exposure to wind turbine noise. The black dots correspond to the estimated RR per 10 dB and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Fig. 15. The association between exposure to wind turbine noise (sound pressure level) and self-reported cardiovascular disease



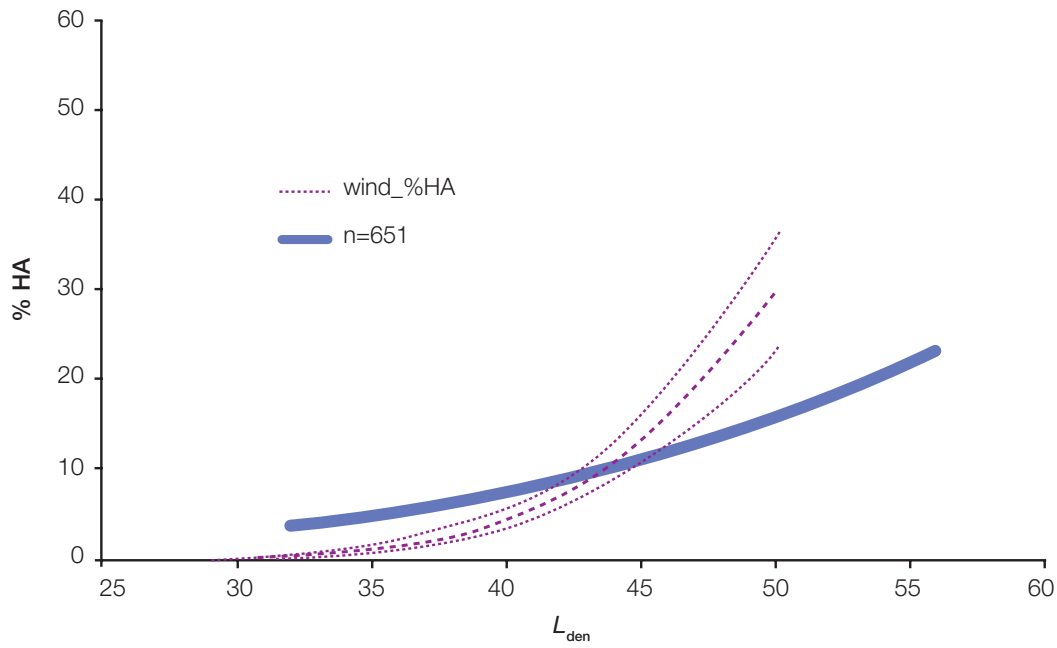
Notes: The dotted vertical line corresponds to no effect of exposure to wind turbine noise.The black circles correspond to the estimated RR per 10 dB (sound pressure level) and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Annoyance

Two publications containing descriptions of four individual studies were retrieved (Janssen et al., 2011; Kuwano et al., 2014). All four studies used measurements in the vicinity of the respondents' addresses; the noise exposure metrics used in the three original studies (Pedersen, 2011; Pedersen & Persson Waye, 2004; 2007) included in Janssen et al. (2011) were recalculated into L_{den}. The noise levels in the studies ranged from 29 dB to 56 dB. Different scales were used to assess annoyance, with slightly different definitions of "highly annoyed" and explicit reference to outdoor annoyance in the data used for the Janssen et al. (2011) curve. Construction of the ERFs provided in the two publications differed and they were therefore not further combined in a meta-analysis. Fig. 16 shows the %HA from the two publications. The 10% criterion for %HA is reached at around 45 dB L_{den} (where the two curves coincide). There was a wide variability in %HA between studies, with a range of 3–13%HA at 42.5 dB and 0–32%HA at 47.5 dB. The %HA in the sample is comparatively high, given the relatively low noise levels. There is evidence rated low quality for an association between wind turbine noise and annoyance, but this mainly applies to the association between wind turbine noise and annoyance and not to the shape of the quantitative relationship.

Further statistical analyses of annoyance yield evidence rated low quality for an association between wind turbine noise and %HA when comparing an exposure at 42.5 dB and 47.5 dB, with a mean difference in %HA of 4.5 (indoors) and 6.4 (outdoors). There is also evidence rated moderate quality for a correlation between individual noise exposure and annoyance raw scores (r = 0.28).

Fig. 16. Overlay of the two wind turbine annoyance graphs



Notes: Overlay of the two wind turbine outdoor annoyance graphs adapted from Janssen et al. (2011, red) and Kuwano et al. (2014, blue). The Kuwano et al. curve is based on L_{dn}; no correction for L_{den} has been applied.[18]
For further details on the studies included in the figure please refer to the systematic review on environmental noise and annoyance (Guski et al., 2017).

Cognitive impairment, hearing impairment and tinnitus, adverse birth outcomes

No studies were found, and therefore no evidence was available on the relationship between wind turbine noise and measures of cognitive impairment; hearing impairment and tinnitus; and adverse birth outcomes.

Sleep disturbance

Six cross-sectional studies on wind turbine noise and self-reported sleep disturbance were identified (Bakker et al., 2012; Kuwano et al., 2014; Michaud, 2015; Pawlaczyk-Luszczynska et al., 2014; Pedersen & Persson Waye, 2004; 2007). Noise levels were calculated using different methods, and different noise metrics were reported. Three of the studies asked how noise affects sleep; the other three evaluated the effect of wind turbine noise on sleep using questions that explicitly referred to noise (Table 40).

[18] L_{dn} is the day-night-weighted sound pressure level as defined in section 3.6.4 of ISO 1996-1:2016.

Table 40. Summary of findings for health effects from exposure to wind turbine noise (L_{night})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of effects in studies	Number of participants (studies)	Quality of evidence
Effects on sleep					
L_{night}	%HSD	1.60 (95% CI: 0.86–2.94) per 10 dB increase	31 dB	3971 (6)	Low (downgraded for study limitations, inconsistency, precision)

The risk of bias was assessed as high for all six studies, as effects on sleep were measured by self-reported data. There were a limited number of subjects at higher exposure levels. A meta-analysis was conducted for five of the six studies, based on the OR for high sleep disturbance for a 10 dB increase in outdoor predicted sound pressure level. The pooled OR was 1.60 (95% CI: 0.86–2.94). The evidence was rated low quality.

3.4.2.2 Evidence on interventions

This section summarizes the evidence underlying the recommendation on the effectiveness of interventions for wind turbine noise exposure. The key question posed was: in the general population exposed to wind turbine noise, are interventions effective in reducing exposure to and/or health outcomes from wind turbine noise? A summary of the PICOS/PECCOS scheme applied is set out in Table 41.

Table 41. PICOS/PECCOS scheme of the effectiveness of interventions for exposure to wind turbine noise

PICO	Description	
Population	**General population**	
Intervention(s)	The interventions can be defined as: (a) a measure that aims to change noise exposure and associated health effects; (b) a measure that aims to change noise exposure, with no particular evaluation of the impact on health; or (c) a measure designed to reduce health effects, but that may not include a reduction in noise exposure.	
Comparison	**No intervention**	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

No studies were found, and therefore no evidence was available on the effectiveness of interventions to reduce noise exposure from wind turbines.

3.4.2.3 Consideration of additional contextual factors

As the foregoing overview has shown, very little evidence is available about the adverse health effects of continuous exposure to wind turbine noise. Based on the quality of evidence available, the GDG set the strength of the recommendation on wind turbine noise to conditional. As a second step, it qualitatively assessed contextual factors to explore whether other considerations could have a relevant impact on the recommendation strength. These considerations mainly concerned the balance of harms and benefits, values and preferences, and resource use and implementation.

Regarding the balance of harms and benefits, the GDG would expect a general health benefit from a marked reduction in any kind of long-term environmental noise exposure. Health effects of individuals living in the vicinity of wind turbines can theoretically be related not only to long-term noise exposure from the wind turbines but also to disruption caused during the construction phase. The GDG pointed out, however, that evidence on health effects from wind turbine noise (apart from annoyance) is either absent or rated low/very low quality (McCunney et al., 2014). Moreover, effects related to attitudes towards wind turbines are hard to discern from those related to noise and may be partly responsible for the associations (Knopper & Ollson, 2011). Furthermore, the number of people exposed is far lower than for many other sources of noise (such as road traffic). Therefore, the GDG estimated the burden on health from exposure to wind turbine noise at the population level to be low, concluding that any benefit from specifically reducing population exposure to wind turbine noise in all situations remains unclear. Nevertheless, proper public involvement, communication and consultation of affected citizens living in the vicinity of wind turbines during the planning stage of future installations is expected to be beneficial as part of health and environmental impact assessments. In relation to possible harms associated with the implementation of the recommendation, the GDG underlined the importance of wind energy for the development of renewable energy policies.

The GDG noticed that the values and preferences of the population towards reducing long-term noise exposure to wind turbine noise vary. Whereas the general population tends to value wind energy as an alternative, environmentally sustainable and low-carbon energy source, people living in the vicinity of wind turbines may evaluate them negatively. Wind turbines are not a recent phenomenon, but their quantity, size and type have increased significantly over recent years. As they are often built in the middle of otherwise quiet and natural areas, they can adversely affect the integrity of a site. Furthermore, residents living in these areas may have greater expectations of the quietness of their surroundings and therefore be more aware of noise disturbance. Negative attitudes especially occur in individuals who can see wind turbines from their houses but do not gain economically from the installations (Kuwano et al., 2014; Pedersen & Persson Waye, 2007; van den Berg et al., 2008). These situational variables and the values and preferences of the population may differ between wind turbines and other noise sources, as well as between wind turbine installations, which makes assessment of the relationship between wind turbine noise exposure and health outcomes particularly challenging.

Assessing resource use and implementation considerations, the GDG noted that reduction of noise exposure from environmental sources is generally possible through simple measures like insulating windows or building barriers. With wind turbines, however, noise reduction interventions are more

complicated than for other noise sources due to the height of the source and because outdoor disturbance is a particularly large factor. As generally fewer people are affected (compared to transportation noise), the expected costs are lower than for other environmental sources of noise. The GDG was not aware of any existing interventions (and associated costs) to reduce harms from wind turbine noise, or specific consequences of having regulations on wind turbine noise. Therefore, it could not assess feasibility, or discern whether any beneficial effects of noise reduction would outweigh the costs of intervention. In particular, there is no clear evidence on an acceptable and uniform distance between wind turbines and residential areas, as the sound propagation depends on many aspects of the wind turbine construction and installation.

In light of the assessment of the contextual factors in addition to the quality of evidence, the recommendation for wind turbine noise exposure remains conditional.

Additional considerations or uncertainties

Assessment of population exposure to noise from a particular source is essential for setting health-based guideline values. Wind turbine noise is characterized by a variety of potential moderators, which can be challenging to assess and have not necessarily been addressed in detail in health studies. As a result, there are serious issues with noise exposure assessment related to wind turbines.

Noise levels from outdoor sources are generally lower indoors because of noise attenuation from the building structure, closing of windows and similar. Nevertheless, noise exposure is generally estimated outside, at the most exposed façade. As levels of wind turbine noise are generally much lower than those of transportation noise, the audibility of wind turbines in bedrooms, particularly when windows are closed, is unknown.

In many instances, the distance from a wind farm has been used as a proxy to determine audible noise exposure. However, in addition to the distance, other variables – such as type, size and number of wind turbines, wind direction and speed, location of the residence up- or downwind from wind farms and so on – can contribute to the resulting noise level assessed at a residence. Thus, using distance to a wind farm as a proxy for noise from wind turbines in health studies is associated with high uncertainty.

Wind turbines can generate infrasound or lower frequencies of sound than traffic sources. However, few studies relating exposure to such noise from wind turbines to health effects are available. It is also unknown whether lower frequencies of sound generated outdoors are audible indoors, particularly when windows are closed.

The noise emitted from wind turbines has other characteristics, including the repetitive nature of the sound of the rotating blades and atmospheric influence leading to a variability of amplitude modulation, which can be a source of above average annoyance (Schäffer et al., 2016). This differentiates it from noise from other sources and has not always been properly characterized. Standard methods of measuring sound, most commonly including A-weighting, may not capture the low-frequency sound and amplitude modulation characteristic of wind turbine noise (Council of Canadian Academies, 2015).

Even though correlations between noise indicators tend to be high (especially between L_{Aeq}-like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to

wind turbine noise in L_{den} is converted from original sound pressure level values. The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes.

Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes.

3.4.3 Summary of the assessment of the strength of recommendations

Table 42 provides a comprehensive summary of the different dimensions for the assessment of the strength of the wind turbine recommendations.

Table 42. Summary of the assessment of the strength of the recommendation

Factors influencing the strength of recommendation	Decision
Quality of evidence	**Average exposure (L_{den})** *Health effects* • Evidence for a relevant absolute risk of annoyance at **45 dB L_{den}** was rated **low quality.** *Interventions* • No evidence was available on the effectiveness of interventions to reduce noise exposure and/or health outcomes from wind turbines. **Night-time exposure (L_{night})** *Health effects* • No statistically significant evidence was available for sleep disturbance related to exposure from wind turbine noise at night. *Interventions* • No evidence was available on the effectiveness of interventions to reduce noise exposure and/or sleep disturbance from wind turbines.
Balance of benefits versus harms and burdens	Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region.
Values and preferences	There is wide variability in the values and preferences of the population, with particularly strong negative attitudes in populations living in the vicinity of wind turbines.
Resource implications	Information on existing interventions (and associated costs) to reduce harms from wind turbine noise is not available.
Additional considerations or uncertainties	There are serious issues with noise exposure assessment related to wind turbines.
Decisions on recommendation strength	• **Conditional** for guideline value for average noise exposure (L_{den}) • **Conditional** for the effectiveness of interventions (L_{night})

3.5 Leisure noise

Recommendations

For average noise exposure, the GDG **conditionally** recommends reducing the yearly average from all leisure noise sources combined to **70 dB** $L_{Aeq,24h}$, as leisure noise above this level is associated with adverse health effects. The equal energy principle[19] can be used to derive exposure limits for other time averages, which might be more practical in regulatory processes.

For single-event and impulse noise exposures, the GDG **conditionally** recommends following existing guidelines and legal regulations to limit the risk of increases in hearing impairment from leisure noise in both children and adults.

Following a precautionary approach, to reduce possible health effects, the GDG **strongly** recommends that policy-makers take action to prevent exposure above the guideline values for average noise and single-event and impulse noise exposures. This is particularly relevant as a large number of people may be exposed to and at risk of hearing impairment through the use of personal listening devices (PLDs). There is insufficient evidence, however, to recommend one type of intervention over another.

3.5.1 Rationale for the guideline levels for leisure noise

As specific evidence for the relationship between leisure noise and hearing loss is of insufficient quality, the GDG decided to follow a different approach for this noise source, based on knowledge regarding prevention of hearing loss in the workplace and on the CNG (WHO, 1999). There is sufficient evidence that the nature of the noise matters little in causing hearing loss, so using the existing guidelines is a justified step to prevent permanent hearing loss from leisure noise.

In accordance with the procedures for the other noise sources, the GDG would have considered evidence on exposure–response relationships for the prioritized health outcomes. However, no such ERFs could be established in the systematic reviews for any of the health outcomes (Table 43).

Table 43. Average exposure levels ($L_{Aeq,24h}$) for priority health outcomes from leisure noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Incidence of IHD **Incidence of hypertension** **Prevalence of highly annoyed population** **Reading skills and oral comprehension in children**		No evidence was available
Permanent hearing impairment There is an indication that PLDs have an effect on hearing impairment and tinnitus. There was no evidence (because no studies were found) for an effect of other sources of leisure noise on hearing impairment or tinnitus. The results of the studies could not be synthesized because of heterogeneity of outcome measurement.	No increase	Very low quality/no evidence

[19] The equal energy principle states that the total effect of sound is proportional to the total amount of sound energy received by the ear, irrespective of the distribution of that energy in time (WHO, 1999).

In accordance with the evidence on the effects of PLDs on permanent hearing loss from leisure noise, the GDG recommended a guideline exposure level of 70 dB $L_{Aeq,24h}$ yearly average from all leisure noise sources combined. It was confident that there was no relevant risk increase for permanent hearing impairment below this exposure level of average leisure noise. The GDG recognized that a conversion to alternative time averages for exposure to leisure noise might be helpful for regulatory purposes; thus, a detailed table converting hourly and weekly exposure into yearly averages is provided in the subsection on additional considerations or uncertainties in section 3.5.2.3, Table 49. Furthermore, the GDG recommended sticking to the CNG recommendations for single events to limit the risk of hearing impairment from leisure noise increases for both children and adults (WHO, 1999).[20] Due to the nature and limited amount of available evidence, the GDG made the recommendation conditional.

Next, the GDG assessed the evidence for night noise exposure and its effect on sleep disturbance (Table 44).

Table 44. Night-time exposure levels (L_{night}) for priority health outcomes from leisure noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Sleep disturbance	3% absolute risk	No evidence was available

Because of a lack of evidence, the GDG was not able to formulate a recommendation addressing sleep disturbance due to leisure noise at night time.

The GDG also looked for evidence about the effectiveness of interventions for leisure noise exposure. Owing to a lack of research, however, no studies were available on existing interventions and associated costs to reduce leisure noise. As no evidence was available, it was not possible to develop a recommendation on any specific type of intervention measure. However, following a precautionary approach, to reduce possible health effects, the GDG made a strong recommendation that policy-makers take action to prevent exposures above the guideline values for average noise and single-event and impulse noise exposures. This is particularly relevant as a large number of people may be exposed to and at risk of hearing impairment through the use of PLDs. There is insufficient evidence, however, to recommend one type of intervention over another.

3.5. 1.1 Other factors influencing the strength of recommendations

Other factors considered in the context of recommendations on leisure noise included those related to values and preferences, benefits and harms, resource implications, equity, acceptability and feasibility; moreover, nonpriority health outcomes were considered. Ultimately, the assessment of all these factors did not lead to a change in the strength of recommendation. Further details are provided in section 3.5.2.3.

[20] The GDG acknowledged the scarcity of cohort study-based evidence to define a threshold for hearing damage due to single loud exposures. It initially decided to propose $L_{AF,max}$ = 110, but after much discussion it appeared that the conversion of relevant standing limits (expressed in $L_{peak,C}$ and others) lacked sufficient basis.

3.5.2 Detailed overview of the evidence

The following sections provide a detailed overview of the evidence constituting the basis for setting the recommendations on leisure noise. As noted above, however, only limited evidence was available for several of the prioritized health outcomes, so it is presented and summarized for all critical and important health outcomes where possible, along with indications of the GDG's judgement of the quality of evidence. Research into health outcomes and effectiveness of interventions is addressed consecutively.

A comprehensive summary of all evidence considered for each of the critical and important health outcomes can be found in the eight systematic reviews published in the *International Journal of Environmental Research and Public Health* (see section 2.3.2 and Annex 2).

3.5.2.1 Evidence on health outcomes

The key question posed was: in the general population exposed to leisure noise, what is the exposure–response relationship between exposure to leisure noise (reported as various noise indicators) and the proportion of people with a validated measure of health outcome, when adjusted for main confounders? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 45 and 46.

Table 45. PICOS/PECCOS scheme of critical health outcomes for exposure to leisure noise

PECO	Description	
Population	General population	
Exposure	Exposure to high levels of noise produced by leisure activities (average/night time)	
Comparison	Exposure to lower levels of noise produced by leisure activities (average/night time)	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 46. Summary of findings for health effects from exposure to leisure noise ($L_{Aeq,24h}$)

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies[a]	Number of participants (studies)	Quality of evidence
Cardiovascular disease					
$L_{Aeq,24}$	Incidence of IHD	–	–	–	–
$L_{Aeq,24}$	Incidence of hypertension	–	–	–	–
Annoyance					
$L_{Aeq,24}$	%HA	–	–	–	–
Cognitive impairment					
$L_{Aeq,24}$	Reading and oral comprehension	–	–	–	–
Hearing impairment and tinnitus					
$L_{Aeq,24}$	Permanent hearing impairment	Not estimated	–	484 (3)	Very low (downgraded for study limitations, precision)

Hearing impairment and tinnitus

Several types of leisure activity are accompanied by loud sounds, such as attending nightclubs, pubs and fitness classes; live sporting events; concerts or live music venues; listening to loud music through PLDs. This recommendation is informed by a systematic review that assessed the evidence on permanent hearing loss and tinnitus due to exposure to leisure noise (Śliwińska-Kowalska & Zaborowski, 2017). The review identified two existing systematic reviews that summarized recent estimates of the risk of developing permanent hearing loss from the use of PLDs. It did not identify any studies with objective measurement of exposure to any other type of leisure noise.

The Scientific Committee on Emerging and Newly Identified Hazards and Risk (SCENIHR) (EC, 2008b) report concluded that prolonged exposure to sounds from PLDs may result in temporary hearing threshold shift, permanent hearing threshold shift and tinnitus, as well as poor speech communication in noisy conditions. However, based on the data available, there was no direct evidence for an effect of repeated, regular daily exposure to music through PLDs on development of permanent noise-induced hearing loss. Data on tinnitus were inadequate and therefore inconclusive. No meta-analysis was provided for any of the hearing effects; nor were the exposure–effect curves reported. The SCENIHR report was based on a narrative review of 30 original papers with over 2000 participants and exposure to music sounds that covered a range of 60–120 dB. Studies included in the review were carried out between 1982 and 2007.

In 2014 a second systematic review was published by Vasconcellos et al. (2014). Although the objective of this publication was to determine threshold levels of personally modifiable risk factors for hearing loss in the paediatric population, specific thresholds analyses were limited. Based on the descriptive overview of original papers, the authors identified exposure to loud music (including use of PLDs) and working on a mechanized farm as the main risk factors for hearing loss in children

and teenagers. Thresholds of exposure to music, significantly associated with hearing loss in youth, were:

- more than four hours per week or more than five years of personal headphone usage;
- more than four visits per month to a discotheque.

The evidence review identified five new cross-sectional studies on noise from PLDs since the publication of the SCENIHR report (Feder et al., 2013; Levesque et al., 2010; Sulaiman et al., 2013; 2014; Vogel et al., 2014). Direct measurement of hearing thresholds with pure tone audiometry was performed only in three studies – by Feder et al. (2013) and Sulaiman et al. (2013 and 2014). In total, audiometric data from 484 subjects were analysed; among them, 449 were exposed and 35 were not exposed to PLD music. Two other studies by Levesque et al. (2010) and Vogel et al. (2014) did not perform audiometric measurement but reported on tinnitus in a total of 1067 participants.

Noise from PLDs was estimated based on direct measurement of equivalent sound pressure levels (in dB) in four studies (Feder, 2013; Levesque et al., 2010; Sulaiman et al., 2013; 2014) and based on converting volume-control setting levels of PLD into dB levels in one study (Vogel et al., 2014). The resulting exposure levels (L_{Aeq} values) had a mean of between 72 dB and 91 dB, although in two studies these data were not provided. In all studies, individual $L_{Aeq,8h}$ value was calculated based on an estimated level of music and the number of hours a day listening to the music through the PLD declared by an individual in the questionnaire. Resulting $L_{Aeq,8h}$ mean values were between 62 dB and 83 dB when provided.

Potential confounding was controlled by excluding the subjects with exposure to other sources of high-level noise or prior ear problems (Sulaiman et al., 2013), by excluding those with these factors and ototoxic drug intake (Sulaiman et al., 2014) or by controlling for these confounders by accounting for them in the statistical models. The confounders comprised socioeconomic status, demographic factors, tubes in the ear and leisure exposures in one study (Feder, 2013), and age and sex in one study (Vogel et al., 2014). One of the studies did not adjust for confounding factors (Levesque et al., 2010).

Data on permanent hearing loss were taken from audiometric measurements (Feder, 2013; Sulaiman et al., 2013; 2014), while data about permanent tinnitus were taken from self-reported responses to questionnaires (Levesque et al., 2010; Vogel et al., 2014). In one case, the outcome was defined as “permanent hearing-related symptoms”, but it is not clear what proportion of subjects experienced permanent tinnitus (Vogel et al., 2014).

For permanent hearing loss, there is no pooled effect size, because the authors of the original studies either did not report data or reported in different formats. However, these studies indicate a harmful effect of listening to PLDs. For permanent tinnitus, there is no pooled effect size because the effects of noise from PLDs on permanent tinnitus were contradictory. These results are generally consistent with previous reviews by SCENIHR (EC, 2008b) and Vasconcellos et al. (2014).

The risk of bias was assessed as high for all five studies. The overall evidence for an effect of PLDs on hearing impairment and tinnitus was rated very low quality.

3.5.2.2 Evidence on interventions

The following section summarizes the evidence underlying the recommendation on the effectiveness of interventions for leisure noise exposure. The key question posed was: in the general population exposed to leisure noise, are interventions effective in reducing exposure to and/or health outcomes from leisure noise? A summary of the PICOS/PECCOS scheme applied and the main findings is set out in Tables 47 and 48.

Table 47. PICOS/PECCOS scheme of the effectiveness of interventions for exposure to leisure noise

PICO	Description	
Population	General population	
Intervention(s)	The interventions can be defined as: (a) a measure that aims to change noise exposure and associated health effects; (b) a measure that aims to change noise exposure, with no particular evaluation of the impact on health; or (c) a measure designed to reduce health effects, but that may not include a reduction in noise exposure.	
Comparison	No intervention	
Outcome(s)	For average noise exposure: 1. cardiovascular disease 2. annoyance 3. cognitive impairment 4. hearing impairment and tinnitus 5. adverse birth outcomes 6. quality of life, well-being and mental health 7. metabolic outcomes	For night noise exposure: 1. effects on sleep

Table 48. Summary of findings for interventions for leisure noise

Type of intervention	Number of participants (studies)	Effect of intervention	Quality of evidence
Hearing impairment			
Type E – behaviour change interventions (education programme/campaign)	4151 (7)	None of the studies involved measurement or estimation of exposure levels or health outcomes. Most studies found a significant effect of change in knowledge or behaviour.	–

Seven individual studies on PLDs, attendance at music venues and participation in other recreational activities where there was risk of hearing damage and/or tinnitus were included in the systematic review (Dell & Holmes, 2012; Gilles & Van de Heyning, 2014; Kotowski et al., 2011; Martin et al., 2013; Taljaard et al., 2013; Weichbold & Zorowka, 2003; 2007). All studies examined interventions directed at changes in knowledge or behaviour and hearing impairment.

The studies all sought evidence on the effectiveness of some form of educational programme or campaign aimed at children, adolescents or college students. These addressed perceptions and

knowledge of the risk of high levels of noise – generally, but not exclusively, from PLD sources or from attendance at music events – and actual or intended changes to hearing damage risk behaviours, including avoidance, frequency or duration of exposure, regeneration periods when in high noise, or playback levels.

The outcome assessed in all intervention studies was the change in knowledge and behaviours towards hearing damage risk. The health outcome measures varied widely and included measurements on the youth attitude towards noise scale, participants' knowledge about hearing damage, participants' PLD usage patterns, participants' attitudes to wearing hearing protection (some in general; some at discotheques) and frequency of discotheque attendance. A majority of the studies found a significant effect of change in knowledge or behaviour. No indication on the persistence of knowledge and behavioural change was given, though.

None of the studies included objectively measured outcomes or a measured change in noise level exposure; thus, the effectiveness of the interventions could not be assessed, and the quality of the evidence was not rated according to GRADE.

3.5.2.3 Consideration of additional contextual factors

Based on the quality of the available evidence discussed in the foregoing overview, the GDG set the strength of recommendation of leisure noise to conditional. As a second step, it qualitatively assessed contextual factors to explore whether other considerations could have a relevant impact on the recommendation strength. These considerations mainly concerned the balance of harms and benefits, values and preferences, and resource use and implementation.

When assessing the balance of benefits and harms, the GDG recognized that exposure to leisure noise is widespread and frequent. In particular, as many as 88–90% of teenagers and young adults report listening to music through PLDs earphones (Pellegrino et al., 2013; Vogel et al., 2011). In 2015 WHO estimated that 1.1 billion young people worldwide could be at risk of hearing loss due to unsafe listening practices (WHO, 2015a). Furthermore, among young people aged 12–35 years in middle- and high-income countries, nearly 50% listen to unsafe levels of sound through personal audio devices (mp3 players, smartphones and others), and around 40% are exposed to potentially damaging levels of sound at nightclubs, bars and sporting events. Noise-induced hearing loss can be prevented by following safe listening practices, so the GDG concluded that health benefits can be gained from markedly reducing population exposure to leisure noise, including through actions to promote safe listening practices. A reduction of leisure noise is also assumed to reduce nuisance that can be caused to other people than those who enjoy leisure activities, such as neighbours. Furthermore, specifically for PLDs, it can reasonably be expected that a reduction of noise exposure could also lead to a reduction in accidents, injuries and other potential safety risks. In relation to possible harms and burdens, the GDG could not identify any harms (except economic costs, which are addressed in the paragraph on resource use and implementation) arising from implementation of the recommended guideline values.

Considering values and preferences, the GDG recognized that listening to music with the help of a PLD, going to concerts and attending sport events are activities regarded as enjoyable and therefore assumed to be valued by the overall population. Furthermore, it is expected that values and preferences might vary in particular with respect to the use of PLDs and embracing leisure activities

involving loud noise, like concerts, and that some population groups – especially younger individuals – might voluntarily expose themselves to high levels of sound during these activities. Despite this, the GDG was confident that recommendations to lower noise levels for the prevention of hearing damage from leisure noise would be welcome by a majority of the population. Recommendations are expected to be particularly welcome when it comes to protecting the hearing of young children and teenagers, as these vulnerable groups often do not have control over their environment and the noise levels to which they are exposed, such as from noisy toys or at school.

With resource use and implementation, the GDG noted that interventions exist to reduce exposure to leisure noise from PLDs, attendance at music venues and participation in recreational activities, as aggregated by the systematic review on environmental noise interventions and their associated impacts (Brown & van Kamp, 2017). As most of these relate to implementation of a behaviour change, the reduction of exposure to leisure noise is expected to be technically feasible and cheap. None of the empirical investigations objectively measured outcomes or a measured change in noise level exposure, so the effectiveness of such measures cannot be assessed. Nevertheless, it is important to note that there is ample evidence from the occupational health field that high noise levels cause hearing damage, and that occupational interventions to reduce noise exposure are effective at lowering the risk of hearing problems or hearing damage (EC, 2003; Garcia et al., 2018; ISO, 2013; Maassen et al., 2001). In conclusion, resources needed to reduce exposure to leisure noise are not expected to be intensive, but implementation and long-term success of measures might be challenging, owing to cultural factors, as changes in behaviour are expected to be tricky to implement.

In light of the assessment of the contextual factors in addition to the quality of evidence, the recommendation remains conditional.

Additional considerations or uncertainties

The GDG considers the noise levels selected for this recommendation to be reasonable precautionary measures, in view of the rating of very low quality for the available evidence on an effect of leisure noise on permanent hearing impairment and tinnitus identified in the systematic review.

Extensive literature shows hearing impairment in populations exposed to specific types of nonoccupational environments, although these exposures are generally not well characterized. There are no studies with objective measurement of exposure to any other type of leisure noise (except PLDs) and permanent hearing impairment or tinnitus. Nevertheless, this recommendation generally applies to all leisure noise exposures, such as events in public venues (concerts halls, sports events, bars and discotheques) and educational facilities, and use of PLDs. The recommendation also applies to exposure to impulse sounds, such as those in shooting facilities or from the use of toys and firecrackers.

Hearing loss is the resultant value of combined exposures to different sources of leisure noise including, but not limited to, PLDs. Therefore, the recommendations apply to the combined noise levels from all sources.

Noise-induced hearing loss develops very slowly over years of exposure, giving rise to challenges in the assessment of the health impacts from prolonged use of PLDs and exposure to leisure noise. The induction period for the development of hearing impairment and tinnitus is long, and varying

exposure conditions and changing lifestyle habits (including confounding noise sources), particularly among young people, will have an impact. Therefore, recommendations regarding leisure noise have often been inferred from the occupational field, where exposure conditions are more stable over time.

Indeed, long-term exposure to noise, objectively assessed and at levels measured in occupational settings for various professions, can lead to permanent hearing loss and tinnitus. This evidence, while not reviewed systematically as part of the work related to these guidelines, can be used as supportive evidence and justification for the need to develop a recommendation for leisure noise, given that many people could be at risk of developing hearing loss and/or tinnitus from exposure to lower levels of environmental noise. Similar otobiological mechanisms must also be considered for environmental noise.

To date, no commonly accepted method for assessing the risk of hearing loss due to environmental exposure to noise has been developed. One of the main challenges is to conduct a long-term objective exposure assessment of environmental noise and relate this to the development of permanent hearing impairment and tinnitus. The GDG underlined the strong need for research to develop a comprehensive methodology. In the absence of a method, and as long as no other tools are available, the equal energy principle outlined in the ISO standard for the estimation of noise-induced hearing loss (WHO, 1999) can be used as a practical tool for protecting public health from exposure to leisure noise. As a result, the relationship between leisure noise exposure and auditory effects can be quantified for a variety of exposure levels, duration and frequency.

Several organizations have established regulations for the protection of workers from risks to their health and safety arising from exposure to noise, and in particular risk to hearing. Of particular relevance is EU Directive 2003/10/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (EC, 2003). Based on the ISO 1999 standard (ISO, 2013), the Directive sets limits of exposure depending on equivalent noise level for an eight-hour working day and obliges the employer to take suitable steps if the limits are exceeded. It recommends three action levels for occupational settings, setting the lowest, most conservative value at $L_{ex,8hr}$ = 80 dB. According to the Directive, no consequences of exposure to occupational noise are expected at this level. While exposure patterns and certain characteristics of occupational and leisure noise exist, knowledge of the hearing impairment risks and preventive interventions can be used to assess health risks associated with leisure noise (Neitzel & Fligor, 2017).

The CNG recommend a limit of $L_{Aeq,24h}$ = 70 dB(A) for preventing hearing loss from industrial, commercial shopping and traffic areas, indoors and outdoors (WHO, 1999). Health and safety regulations are usually based on an exposure profile of a typical worker (eight hours per day, five days per week). Using the existing knowledge from the ISO standard and established health and safety regulations, it is possible to use the equal energy principle to derive the resulting noise exposure level for an exposure profile more appropriately suited for leisure noise. Converting 40 hours at 80 dB to a continuous exposure to noise (24 hours per day, seven days per week), this leads to a yearly average exposure of 71 dB for lifelong exposure.[21] This is the same value as the WHO recommendation of

[21] 71 dB = 80 dB (derived from ISO standard) – 6.2 dB (conversion of yearly average of 40 working hours divided by continuous exposure to noise: (10 log (2080hrs/8760 hrs)) – 3 dB (extrapolation of 40 working years to lifelong exposure).

70 dB (WHO, 1999). Table 49 presents the noise levels per hour for various time averages in order to keep within the recommended yearly average exposure, and assuming that exposure to other noise sources generally does not contribute significantly. For example, for specific events taking place for one-, two- or four-hour averages, once a week (such as visiting a discotheque or watching a loud movie), an hourly noise level of 85 dB would lead to an average yearly exposure of 63 dB, 66 dB and 69 dB, respectively. However, the same hourly exposure of 85 dB for an activity taking place for 14 hours per week (two hours per day, seven days a week) would lead to a yearly exposure of 74 dB, which exceeds the recommendations.

Table 49. Combination of hourly exposure and number of hours per week to arrive at a yearly average L_{Aeq}

Hours of exposure per week	One-hour exposure level (L_{Aeq})						
	70	75	80	85	90	95	100
1	48	53	58	63	68	73	78
2	51	56	61	66	71	76	81
4	54	59	64	69	74	79	84
14 (2 hours per day, 7 days per week)	59	64	69	74	79	84	89
28 (4 hours per day, 7 days per week)	62	67	72	77	82	87	92
40 (8 hours per day, 5 days per week)	64	69	74	79	84	89	94
168 (24 hours per day, 7 days per week)	70	75	80	85	90	95	100

Note: green = combinations of exposure/duration below current guideline level; red = combinations of exposure/duration above current guideline level; blue = input parameters.

The equal energy principle cannot be used to derive single-event limits because at high levels the ear starts to respond with nonlinear behaviour. The CNG provides several values, in different units: $L_{AF,max}$ = 110 dB for industrial noises (no distance stated), $L_{peak,lin}$ = 140 dB for adults and $L_{peak,lin}$ = 120 dB for children (measured at 100 mm) (WHO, 1999). EU Directive 2003/10/EC on the minimum health and safety requirements regarding the exposure of workers recommends a lower action level of $L_{peak,C}$ = 135 dB (at 100 mm). In a recent overview Hohmann (2015) provided an ERF for hearing damage caused by shooting noise, from which it appears that a safe level of L_E = 120 dB can be derived.

Although it is clear that high noise levels cause acute hearing damage, there is no agreement on a safe level. Further research is highly recommended. In the mean time, existing guidelines should be applied.

3.5.3 Summary of the assessment of the strength of recommendation

Table 50 provides a comprehensive summary of the different dimensions for the assessment of the strength of the leisure noise recommendations.

Table 50. Summary of the assessment of the strength of the recommendation

Factors influencing the strength of recommendation	Decision
Quality of evidence	**Average exposure ($L_{Aeq,24h}$)** *Health effects* • Evidence of an effect from PLDs on hearing impairment and tinnitus, in the absence of evidence for other health outcomes and absence of evidence on hearing impairment and tinnitus from other types of leisure noise besides PLDs, was rated **very low quality.** *Interventions* • No evidence was available on the effectiveness of interventions to reduce noise exposure and/or health outcomes from leisure noise.
Balance of benefits versus harms and burdens	The general benefit from reduction of leisure noise outweighs any potential harms.
Values and preferences	There is variability in the values and preferences of the general population.
Resource implications	The resources needed to reduce exposure to leisure noise are not expected to be intensive, but implementation and the long-term success of measures may be challenging, mainly due to cultural factors.
Decision on strength of recommendation	• **Conditional** for guideline level for average noise exposure ($L_{Aeq,24h}$) • **Conditional** for single-event and impulse noise • **Strong** for interventions to reduce noise exposure

3.6 Interim targets

An interim target was proposed in the NNG (WHO Regional Office for Europe, 2009), "recommended in situations where the achievement of NNG is not feasible in the short run for various reasons". The NNG emphasized that an interim target is "not a health-based limit value by itself. Vulnerable groups cannot be protected at this level".

The GDG discussed whether to propose interim targets as part of the current guidelines, and if so, what process would be needed to derive those values. The current recommendations are health-based and already provide guideline values per noise source (for both L_{den} and L_{night}). They also include information on exposure–response relationships for various health outcomes, which can be used by policy-makers or other stakeholders to inform the selection of different values, if needed. Further, interim targets may work differently in different countries and for different noise sources, and it may not be optimal to propose them Europe-wide. As a result, there was consensus among members of the GDG not to provide interim targets.

4. Implications for research

The development of these environmental noise guidelines for the WHO European Region has made evident some key knowledge gaps and research needs. The main ones specific to the guideline recommendations are presented as implications for research in the sections that follow.

4.1 Implications for research on health impacts from transportation noise

For the assessment of health effects from the main sources of transportation noise (road traffic, railways and aircraft), the various evidence reviews show the following knowledge gap: there is a need for longitudinal studies on the health impacts from exposure to environmental noise, to inform future recommendations properly (Table 51).

Table 51. Implications for research on health impacts from transportation noise (air, rail, road)

Current state of the evidence	Limited evidence is available on health impacts from transportation noise from large-scale cohort and case-control studies, with objective measurement of both noise exposure and health outcomes.
Population of interest	Research is needed into effects of exposure on children and adults exposed to environmental noise from transportation sources.
Exposure of interest	Objective measurement or calculation of transportation noise exposure is required; in particular, from studies of health effects related to combined exposure to different noise sources.
Comparison of interest	The data should be compared to the effects of lower levels of transportation noise.
Outcomes of interest	Measures of the following health outcomes is required, assessed objectively and harmonized where possible – for example, according to common protocols: • annoyance • effects on sleep • cardiovascular and metabolic effects • adverse birth outcomes • cognitive impairment • mental health, quality of life and well-being • hearing impairment and tinnitus • any other relevant health outcome.
Time stamp	The systematic review included studies between October 2014 and December 2016.

4.1.1 Specific implications for annoyance

To predict absolute %HA at the full range of levels (and the corresponding CIs), an integrated analysis of the original raw data from all of individual studies would be necessary. The evidence review conducted as part of the guidelines focused only on secondary data handling and therefore does not replace a full meta-analysis of all individual data. The development of a generic exposure–response relationship (from a full meta-analysis based on all individual data) is suggested as a priority research recommendation (see Table 52).

Table 52. Recommendation for research addressing the exposure–response relationship

Current state of the evidence	The evidence review on annoyance conducted as part of the guidelines does not provide a generalized ERF but points to significant differences compared to the curves used in the past. It shows that the available generalized ERFs are in need of adjustment, preferably as a result of undertaking a full meta-analysis. This is especially the case for the sources aircraft and railway noise, which new data show are more annoying than previously documented.
Population of interest	Research is needed into effects of exposure on children and adults exposed to air, rail and/or road traffic noise.
Exposure of interest	Objective measurement of transportation noise exposure is required.
Comparison of interest	The data should be compared to the effects of lower levels of transportation noise.
Outcomes of interest	Measures of health outcomes are required, assessed objectively according to common protocols (such as the International Commission on Biological Effects of Noise (ICBEN) scale for annoyance).
Time stamp	The systematic review included studies up to October 2014.

4.2 Implications for research on health impacts from wind turbine noise

Further research into the health impacts from wind turbine noise is needed so that better-quality evidence can inform any future public health recommendations properly. For the assessment of health effects from wind turbines, the evidence was either unavailable or rated low/very low quality. Recommendations for research addressing this priority are proposed in Table 53.

Table 53. Implications for research on health impacts from wind turbine noise

Current state of the evidence	The current evidence on health outcomes related to wind turbine noise is unavailable or of low/very low quality and mainly comes from cross-sectional studies. Methodologically robust longitudinal studies with large samples investigating the quantitative relationship between noise from wind turbines and health effects are needed.
Population of interest	Research is needed into effects of exposure on children and adults exposed and living near sources of wind turbine noise. Studies should assess subgroup differences in effects for vulnerable groups such as children, elderly people and those with existing poor physical and mental health.
Exposure of interest	Exposure to noise at a wide range of levels and frequencies (including low-frequency noise), with information on noise levels measured outdoors and indoors (particularly relevant for effects on sleep) at the residence is needed. The noise exposure should be measured objectively and common protocols for exposure to wind turbine noise should be established, considering a variety of noise characteristics specific to wind turbine noise.
Comparison of interest	The data should be compared to the effects in similar areas without wind turbines. Pre/post studies of new wind turbine installations are needed, especially if “before measures” unbiased by the stress and knowledge of potential wind turbine farm development need to be developed.
Outcomes of interest	Measures of health outcomes are required, assessed objectively – for example, according to common protocols (ICBEN scale for annoyance and self-reported sleep disturbance). The studies should include the most important situational and personal confounding variables, such as negative attitudes towards wind turbines, visual impact, economic gain and other socioeconomic factors.
Time stamp	The systematic review included studies between October 2014 (review on annoyance) and December 2016 (review on cardiovascular disease).

Alongside the defined needs for research on wind turbine noise it should be noted that research regarding industrial noise in general is required. More specifically, there is a need to investigate stationary sources (including heat, ventilation and acclimatization devices) and their impacts on health. Studies on hearing disorders from impulse and/or intermittent sounds are also needed; these would enable assessment of adverse effects created by one or several sounds of short duration with a high maximum sound level or impulse sound level.

4.3 Implications for research on health impacts from leisure noise

For the assessment of effects from leisure noise, the evidence to make a recommendation on the ERF to use for health risk assessment, or of a threshold for effects, was either unavailable or rated very low quality. This is a research gap: longitudinal studies with longer follow-up are needed; these should measure noise objectively, not only from PLDs but also from other types of leisure noise.

There is uncertainty in the measurement of early hearing disorders among young people using the tonal audiometry commonly applied. Precise methods to identify early hearing impairment and other hearing disorders are needed. Owing to long induction periods, however, adequate research may be difficult to perform, particularly among young people who change their exposure in terms of sound level and frequency as they age (for example, changing their music listening habits and venue visits). As a result, the recommendations refer to the results derived from stationary noise sources in the occupational field, in conjunction with the equal energy principle (see Table 54).

Table 54. Implications for research on health impacts from leisure noise

Current state of the evidence	Currently, no evidence is available on hearing impairment and tinnitus from large-scale cohort and case-control studies, with objective measurement of noise exposure and using a suitable method to assess hearing impairment in young people.
Population of interest	Research is needed into effects of exposure on children and adults exposed to environmental noise from different sources and in different settings.
Exposure of interest	Objective measurement of leisure noise exposure is required.
Comparison of interest	The data should be compared to the effects of no leisure noise exposure from these sources.
Outcomes of interest	The primary outcomes identified are: • hearing loss measured by audiometry; • specific threshold analyses focused on stratifying the risk of permanent hearing loss according to clearly defined levels of exposure to leisure noise, such as music through PLDs; • concise methods to identify early hearing impairment and other hearing disorders; • temporary threshold shift after exposure to leisure noise, as it may be reasonably predictive of future permanent threshold shift; • age-related hearing loss progression depending on early-age exposure to leisure noise, such as to loud music; and • tinnitus, measured objectively and subjectively.
Time stamp	The systematic review included studies up to June 2015.

4.4 Implications for research on effectiveness of interventions to reduce exposure and/or improve public health

The quality of the evidence on the effectiveness of interventions to reduce exposure to and health outcomes from environmental noise was variable. Further studies directly linking noise interventions to health outcomes are required, particularly for sources other than road traffic noise, and for human health outcomes other than annoyance.

Most studies involved road traffic noise (63%), followed by aircraft noise (13%) and railway noise (6%). The remaining interventions were for leisure noise (13%) and noise in hospital settings (4%). No interventions were identified that either addressed wind turbine noise or focused on educational settings.

Exposure-related interventions were mainly associated with a reduction in environmental noise exposure. However, in five studies (four road traffic noise studies and one aircraft noise study) some or all of the participants experienced noise exposure increases.

There is no clear evidence with respect to thresholds, which are defined as:

- the smallest change in exposure levels that results in a change in outcome; and
- the minimum before-level, regarding changes in health outcomes as a result of interventions.

The limited evidence base on the health effects of environmental noise interventions is thinly spread across different noise source types, outcomes and intervention types. Diversity exists between studies even within intervention types in terms of study designs, methods of analysis, exposure levels and changes in exposure experienced as a result of the interventions. For these reasons, carrying out a meta-analysis across studies examining the association between changes in level and changes in outcome was not possible.

To remedy this main research gap, longitudinal studies assessing noise exposure and health outcomes objectively should be developed, taking into account the most relevant confounders. The establishment of common protocols for future research is warranted (see Table 55).

Authorities should include significant funding for the design and implementation of studies to evaluate the effectiveness of interventions to reduce noise and their impact on health.

Table 55. Implications for research on effectiveness of interventions to reduce exposure and/or improve public health

Current state of the evidence	The current evidence on effectiveness of interventions to reduce health outcomes is limited and of varying quality. Few longitudinal studies have been done that take into account the most relevant confounders and measure the noise exposure and the outcomes objectively.
Population of interest	Research is needed into effects of interventions on defined populations exposed to and/or living near sources of environmental noise.
Intervention of interest	Research into any noise intervention at various points along the system pathway between source and outcome, for a variety of noise sources, is required.
Comparison of interest	The data should be compared to: • a steady-state control group, in similar areas with various exposure gradients from environmental noise sources; • the noise exposure in the same population, through a series of sequential measurements assessing the change before and after the intervention, preferably with multiple after measurements.
Outcomes of interest	Future intervention studies should use validated and, where possible, harmonized measures of exposure and outcome, as well as of moderators and confounders. The studies should use measures of exposure including noise exposure at a wide range of levels and frequencies (including low-frequency noise), with information on noise levels outdoors and indoors (particularly relevant for effects on sleep). They should also use measures of health outcomes, including the following outcomes assessed objectively – for example, according to common protocols (ICBEN scale for annoyance) – with consideration that the change in human response for some health outcomes from a step change in exposure may have a different time course to that of the change in exposure: • annoyance • effects on sleep • cardiovascular and metabolic diseases • adverse birth outcomes • cognitive impairment • mental health, quality of life and well-being • hearing impairment and tinnitus • any other relevant health outcome. Further, they should use measures of moderators and confounders, including repeated measurements of situational and personal variables such as activity interference, potential confounders such as noise sensitivity, coping strategies and a range of other attitudinal variables.
Time stamp	The systematic review included studies up to October 2014.

5. Implementation of the guidelines

5.1 Introduction

These guidelines focus on the WHO European Region and provide guidance to Member States that is compatible with the noise indicators used in the EU's END (EC, 2002a). They provide information on the exposure–response relationships between exposure to environmental noise from different noise sources and the proportion of people affected by certain health outcomes, as well as interventions that are considered efficient in reducing exposure to environmental noise and related health outcomes.

The WHO guideline values are evidence-based public health-oriented recommendations. As such, they are recommended to serve as the basis for a policy-making process in which policy options are considered. In the policy decisions on reference values, such as noise limits for a possible standard or legislation, additional considerations – such as feasibility, costs, preferences and so on – feature in and can influence the ultimate value chosen as a noise limit. WHO acknowledges that implementing the guideline recommendations will require coordinated effort from ministries, public and private sectors and nongovernmental organizations, as well as possible input from international development and finance organizations. WHO will work with Member States and support the implementation process through its regional and country offices.

5.2 Guiding principles

Four guiding principles provide generic advice and support when incorporating the recommendations into a policy framework, and apply to the implementation of all the recommendations.

The **first principle** is to reduce exposure to noise, while conserving quiet areas. The recommendations focus on reduction of population exposure to environmental noise from a variety of sources, in different settings. The general population can be exposed regularly to more than one source of noise simultaneously (including, in some cases, occupational noise), as well as to other nonacoustic factors that can modify the response to noise (such as vibration from railways, air pollution from traffic or visual aspects of wind turbines). Thus, overall reduction of exposure from all sources should be promoted. Furthermore, noise exposure reduction in one area should not come at the expense of an increase in noise elsewhere; existing large quiet outdoor areas should be preserved.

The **second principle** is to promote interventions to reduce exposure to noise and improve health. The evidence from epidemiological studies on adverse health effects at certain noise levels, used as a basis to derive the guideline values proposed in the recommendations, supports the promotion of noise interventions. The potential health impacts from environmental noise are significant, especially when considering the widespread exposure to environmental noise across the population and the high baseline rates for various health outcomes associated with environmental noise.

There are challenges in assessment of the effectiveness of interventions to reduce noise exposure and/or improve health, as there is often a significant time lag between the intervention and a measurable change in exposure and related health benefits. The lack of – or limited direct evidence

for – quantifiable health benefits of some specific interventions does not imply that measures to achieve population exposure according to the proposed guidelines should be ignored.

Given the different factors that determine noise exposure, a single measure alone may not be sufficient to reduce exposure and/or improve health significantly, and a combination of methods may be warranted. Nevertheless, it is widely acknowledged that the most effective actions to reduce exposure tend to be those that reduce noise at the source. Such actions have the biggest potential, whereas other measures can be less effective or sustained over time, especially when they depend on behaviour change or noise reductions inside houses.

The **third principle** is to coordinate approaches to control noise sources and other environmental health risks. Considering the common transport-related sources of environmental noise and air pollution, and in particular the evidence of independent effects on the cardiovascular system, a coordinated approach to policy development in the sectors related to urban planning, transport, climate and energy should be adopted for policies with an impact on environmental noise, air quality and/or climate. Such an approach should yield multiple benefits through increased commitment and financial resources; increased attention to securing health considerations in all policies; and use of policy to control noise and other environmental risks such as air pollutants, including short-lived climate pollutants. There is wide consensus on the value of pursuing coordinated policies that can deliver health and other benefits, such as those associated with the local environment and economic development. Furthermore, coordinated policy-making is potentially cost-saving.

The **fourth principle** is to inform and involve communities that may be affected by a change in noise exposure. In planning new urban and/or rural developments (transport schemes, new infrastructures in less densely populated areas, noise abatement and mitigation strategies), bringing together planners, environmental professionals and public health experts with policy-makers and citizens is key to public acceptability and involvement and to the successful guidance of the decision-making proces. Potential health effects from environmental noise should be included as part of health impact assessments of future policies, plans and projects, and the communities potentially affected by a positive or negative change in noise exposure should be well informed and engaged from the outset to maximize potential benefits to health. Introducing measures incrementally may help with acceptance.

5.3 Assessment of national needs and capacity-building

National needs, including the need for capacity-building, differ between Member States in the WHO European Region. They depend on the existence and level of implementation of national and/or European and international noise policies; these are more likely to be implemented fully in EU countries thanks to the legally binding provisions of the EU's END (EC, 2002a). In most countries in the Region noise is perceived as a major and growing environmental health and public health problem. Noise mapping and action plans are carried out in accordance with the END in EU Member States, and in south-eastern European countries noise legislation has mainly been harmonized with the END. Nevertheless, significant differences still exist in the completeness and regular updating of noise exposure assessment between countries. Noise exposure assessment is a required input for noise health impact assessments, along with exposure–response relationships and population baseline data.

WHO has identified some common needs for knowledge transfer and capacity-building for health risk assessment of environment noise in the Member States that joined the EU after 2003, the newly independent states and south-eastern European countries (WHO Regional Office for Europe, 2012):

- implementation of the END and its annexes, especially in the preparation of strategic noise mapping and action plans;
- human resources development through education and training in health risk assessment and burden of diseases stemming from environmental noise;
- methodological guidance for health risk assessment of environmental noise.

These guidelines mostly recommend exposure–response relationships related to the exposure indicators L_{den} and L_{night}. They are therefore of particular relevance to EU countries and those applying the END. In countries that do not use these indicators, users of the guidelines need to convert their noise indicators into L_{den} and L_{night} before being able to apply the recommendations. Conversion between indicators is possible, using a certain set of assumptions (Brink et al., 2018).

5.4 Usefulness of guidelines for target audiences

The provision of guideline values as a practical tool for guiding exposure reduction and the design of effective measures and policies is widely seen as useful. The WHO guidelines equip policy-makers and other end-users with a range of different needs with the necessary evidence base to inform their decisions. As indicated in section 1.4, these guidelines serve as a reference for several target audiences, and for each group they can be useful in different ways.

- For technical experts and decision-makers, the guidelines can be used to provide exposure–response relationships that give insight into the consequences of certain regulations or standards on the associated health effects. They also can be useful at the national and international level when developing noise limits or standards, as they provide the scientific basis to identify the levels at which environmental noise causes a significant health impact. Based on these recommendations, national governments and international organizations can be better informed when introducing noise limits, to ensure protection of people's health.
- For health impact assessment and environmental impact assessment practitioners and researchers, these guidelines provide exposure–response relationships that give insight into the expected health effects at observed or expected noise exposure levels. They offer recommendations on the maximum admissible noise levels for some sources and provide important input to assit in deriving the health burden from noise; in that sense, they can be used when producing studies such as noise maps and action plans to obtain an evaluation of the magnitude of the health problem. The systematic reviews developed in support of these guidelines allow practitioners to raise awareness of the credibility of the issue of noise as a public health problem and to use the recommended exposure–response relationships uniformly. Researchers will also benefit from the guidelines as they clearly identify critical data gaps that need to be filled in the future to better protect the population from the harmful effects of noise.
- The guideline recommendations provide a useful tool for national and local authorities when deciding about noise reduction measures, as they provide data to estimate the health burden on the population and therefore allow comparison among different policy options. These options

can include measures to reduce the noise emitted by the sources, measures aimed at impeding the transmission of noise from the sources to people and measures aimed at better planning the location of houses (urban planning).

- The guideline recommendations can also be used by civil society, patients and other advocacy groups to raise awareness and encourage actions to protect the population, including vulnerable groups, from exposure to noise.

Regarding noise abatement and mitigation of noise sources, practical exposure–response relationships for various noise sources are useful quantitative input to determine the impact of noise on health. They can be valuable information to use in cost–effectiveness and cost–benefit analyses of various policies for noise abatement. In this respect, the guideline recommendations can be an integral part of the policy process for noise reduction by various institutions; they are of great value for communicating the health risks and potential cost-effective solutions to reduce noise.

National and local authorities and nongovernmental organizations responsible for risk communication and general awareness-raising can use these guidelines for promotion campaigns and appropriate risk communication. The guidelines provide scientific evidence on a range of health effects associated with noise and facilitate appropriate risk communication to specific vulnerable groups. They therefore need to be promoted broadly to citizens, national and local authorities and nongovernmental organizations responsible for risk communication.

5.5 Methodological guidance for health risk assessment of environmental noise

A health risk assessment is the scientific evaluation of potential adverse health effects resulting from human exposure to a particular hazard – in this case, environmental noise. The main purpose of the assessment is to estimate and communicate the health impact of exposure to noise or changes in noise in different socioeconomic, environmental and policy circumstances.

The guideline recommendations, along with the detailed information contained in the systematic evidence reviews, can be used to assess health impacts in order to answer a variety of policy questions on:

- the public health burden associated with current or projected levels of noise;
- the human health benefits associated with changing a noise policy or applying a more stringent noise standard;
- the impacts on human health of emissions from specific sources of noise for selected economic sectors (and the benefits of policies related to them); and
- the human health impacts of current policy or implemented action.

The results from a health risk assessment are usually reported as the number of attributable deaths, number of cases, years of life lost, years lost due to disability or DALYs.

The quantification of the impacts for one combination of noise source, noise exposure indicator and health outcome may to some extent include effects attributable to another. Consequently, for any particular set of combinations, consideration should be given to potential double counting.

It is also important to note the uncertainties in quantification of the health impacts. One set of uncertainties relates to the CIs associated with the recommended ERFs; these quantify the random

error and variability attributed to heterogeneity in the epidemiological studies used for health risk assessment. Other types of uncertainty include modelling/calculation of noise exposure, estimates of population background rates for morbidity and mortality, and transferability of ERFs from locations where studies were carried out or data were otherwise gathered to another location. This is especially true for noise annoyance, for which there is often considerable heterogeneity in effect sizes of studies because estimates vary between noise sources and are to some degree dependent on the situation and context. Furthermore, cultural differences around what is considered annoying are significant, even within Europe. It is therefore not possible to determine the "exact value" of %HA for each exposure level in any generalized situation. Instead, data and exposure–response curves derived in a local context should be applied whenever possible to assess the specific relationship between noise and annoyance in a given situation. If, however, local data are not available, general exposure–response relationships can be applied, assuming that the local annoyance follows the generalized average annoyance. Despite the challenges in applying a "generalized" ERF to specific local situations, the GDG believes that the percentage of high annoyance defined in section 2.4.3 is an acceptable estimate of the "average" %HA at a certain noise level – for example, in Europe.

When performing a health risk assessment of environmental noise, it is important to note several considerations. The selection of particular noise source(s), noise exposure indicator(s) and health outcome combinations to be used for estimation of the health impacts depends on the particular policies and/or measures being assessed. These guidelines propose recommendations for four types of noise source using noise indicators L_{den} and/or L_{night} (road traffic, railway noise, aircraft noise and wind turbine noise) and one recommendation using $L_{Aeq,24h}$ (leisure noise). Any population may be exposed to different noise sources associated with the same health outcome. Estimated impacts should not be added together without recognizing that addition will, in most practical circumstances, lead to some overestimation of the true impact. Impacts estimated for only one combination will, on the other hand, underestimate the true impact of the noise mixture, if other sources of noise also affect that same health outcome.

The scientific evidence reviewed and summarized in these guidelines implies that the following health outcomes can be quantified in a health risk assessment, and that their effects are cumulative:

- from road traffic noise – incidence of IHD, annoyance and sleep disturbance, and potentially incidence of stroke and diabetes;
- from railway noise – annoyance and sleep disturbance;
- from aircraft noise – annoyance, reading and oral comprehension in children, sleep disturbance and potentially change in waist circumference and incidence of IHD;
- from wind turbine noise: annoyance.

The DWs suggested in section 2.4.3 can be used to calculate DALYs.

Data on incidence and prevalence of some health outcomes related to noise (mainly cardiovascular disease) can be found at a national level in online databases available on the WHO Regional Office for Europe website (WHO Regional Office for Europe, 2017).

General principles of relevance for environmental factors when conducting health risk assessments and quantifying the burden of disease can be found elsewhere (European Centre for Health Policy, 1999; Murray, 1994; Murray & Acharya, 1997; Murray & Lopez, 2013; Quigley et al., 2006; WHO,

2014a; 2014b; WHO Regional Office for Europe, 2016). In particular, the WHO Regional Office for Europe and JRC jointly published the first estimates of the burden of disease from environmental noise in 2011 (WHO Regional Office for Europe & JRC, 2011). The publication includes guidance on the procedure for the health risk assessment of environmental noise, exemplary estimates of the burden of the health impacts of environmental noise and a discussion of the uncertainties and limitations of the procedure to calculate the environmental burden of disease. The reader is referred to this publication for more detailed explanations on quantitative risk assessment methods for environmental noise.

5.6 Route to implementation: policy, collaboration and the role of the health sector

Preventing noise and related health impacts relies on effective action across different sectors: health, environment, transport, urban planning and so on. The health sector needs to be engaged effectively in different sectors' policy processes at national, regional and international levels. It needs to provide authoritative advice about the health impacts of noise and policy options that will bring the greatest benefits to health.

In most countries in the WHO European Region, the commitment of the health sector to engage in action to address environmental noise issues needs to be improved and better coordinated. A more coherent overall response is needed, taking into account relevant linkages with existing health priorities and concerns. Thus, some actions can be seen as aspects of the role of the health sector:

- engaging in proper communication with relevant sectors about noise exposure from different sectors and sources (environmental, urban development, transport and so on) to ensure that health issues are adequately addressed as part of international, regional, national and/or local efforts to address environmental noise – the implementation approach may differ across sectors, depending on the level of awareness of noise as a public health problem;
- promoting the guideline recommendations to policy-makers from different sectors and organizing information campaigns and awareness-raising activities in collaboration with national health authorities and WHO country offices to inform citizens and health practitioners about the health risks of environmental noise;
- using decision support instruments such as health impact and health risk assessments to quantify health risks and potential benefits associated with policies and interventions aimed at addressing environmental noise, including presenting information about the severity of the health effects (for example, with cardiovascular disease) to convey the serious impacts of noise and to try to change attitudes and behaviours of policy-makers and the general public;
- promoting the guidelines to health practitioners and physicians, especially at the community level (through associations of physicians, cardiologists and so on as part of the stakeholder group);
- supporting the establishment of national health institutions capable of initiating and developing health promotion measures, and conducting research, monitoring and reporting on health impacts from environmental noise and its different sources;

- organizing capacity-building workshops and training to increase knowledge of the guidelines as well as creating tools, skills and resources for health risk assessment and developing intersectoral collaboration, particularly in non-EU countries;
- promoting relevant research initiatives and shaping the research agenda, in part based on critical research recommendations and gaps identified in the guidelines, as well as on the impact and effectiveness of interventions and experience with their implementation;
- developing and updating guidelines and policies that influence national, regional and international benchmarks and targets related to environmental noise, as well as advocating the inclusion of the guidelines in development and shaping of national, regional and international noise policies and standards;
- working with other sectors to strengthen noise level monitoring and evaluation, particularly in non-EU countries, to ensure proper conducting of health risk assessments of environmental noise.

5.7 Monitoring and evaluation: assessing the impact of the guidelines

Exposure–response relationships and other recommendations provided by these guidelines should be incorporated into national health policies and the main related policy documents. They should be used for health impact and health risk assessments to identify health risks and potential benefits associated with policies and interventions related to environmental noise.

Population noise exposure should be monitored and assessed at a national scale, at least in urban areas. Furthermore, information on trends in occurrence of noise-related health outcomes considered in these guidelines, such as annoyance or sleep disturbance, should be gathered. These monitoring activities should be performed on a regular basis to ensure proper health risk assessments of noise.

5.8 Updating the guidelines

The progress and pace of noise and health research has intensified over the last 10 years, including new studies published after the completion of the systematic reviews done for these guidelines. This is partly related to the growing car fleet and resulting traffic, the density of urbanization, demographic changes and shifts towards renewable energy, including wind turbines, which have caused an increase in public perception and political awareness of the environmental noise problem. Noise exposure assessment has also improved, due partly to European legislation, and this has provided useful data for epidemiological studies on the health effects of environmental noise. Considering this, the recommendations proposed in these guidelines are expected to remain valid for a period of about 10 years. WHO will monitor the development of the scientific advancements on noise and health research in order to inform any updated guidance on environmental noise.

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download.php on line 172
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Annexes

Annex 1. Steering, advisory and external review groups

Tables A1.1–A1.5 give details of the various teams involved in the development of the WHO environmental noise guidelines for the European Region.

Table A1.1 WHO Steering Group

Name	Role	Affiliation
Shelly Chadha	Technical Officer, Office for Hearing Impairment	WHO headquarters, Geneva, Switzerland
Carlos Dora	Coordinator	WHO headquarters, Department of Public Health and Environment, Geneva, Switzerland
Marie-Eve Héroux	Technical Officer, Air Quality and Noise	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany
Dorota Jarosinska	Programme Manager, Living and Working Environments	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany
Rokho Kim	Environmental Health Specialist, Team Leader	WHO Regional Office for the Western Pacific, Division of Noncommunicable Diseases and Health through the Life-Course, Manila, Philippines
Jurgita Lekaviciute	Consultant, Noise	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany
Srdan Matic	Coordinator, Environment and Health	WHO Regional Office for Europe, Copenhagen, Denmark
Julia Nowacki	Technical Officer, Health Impact Assessment	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany
Elizabet Paunovic	Head of Office	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany
Poonum Wilkhu	Consultant, Noise	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany
Jördis Wothge	Consultant, Noise	WHO Regional Office for Europe, European Centre for Environment and Health, Bonn, Germany

Table A1.2. Guideline Development Group

Area of expertise	Reference	Area of expertise	Reference
Noise sources and their measurement	1	Annoyance	6
Biological mechanisms of effects	2	Cognitive impairment, quality of life, mental health and well-being	7
Cardiovascular and metabolic diseases	3	Adverse birth outcomes	8
Sleep disturbance	4	Environmental noise interventions	9
Hearing impairment/tinnitus	5	Methodology and guideline development	10

Name	Position and affiliation	Area of expertise sought for guideline development (see reference numbers above)									
		1	2	3	4	5	6	7	8	9	10
Wolfgang Babisch	Senior Scientific Officer (retired) Federal Environment Agency Germany		X	X		X					
Goran Belojevic	Professor Institute of Hygiene and Medical Ecology Faculty of Medicine University of Belgrade Serbia			X			X				
Mark Brink	Senior Scientist Federal Office for the Environment Switzerland	X			X		X				
Sabine Janssen	Senior Scientist Department of Sustainable Urban Mobility and Safety Netherlands Organisation for Applied Scientific Research (TNO) Netherlands				X		X				
Peter Lercher (2013–2014)	Professor Medical University of Innsbruck Austria							X	X		
Marco Paviotti	Policy Officer Directorate-General for Environment European Commission Belgium	X								X	
Göran Pershagen	Professor Institute of Environmental Medicine Karolinska Institute Sweden		X	X					X		

Table A1.2. contd

Area of expertise	Reference	Area of expertise	Reference
Noise sources and their measurement	1	Annoyance	6
Biological mechanisms of effects	2	Cognitive impairment, quality of life, mental health and well-being	7
Cardiovascular and metabolic diseases	3	Adverse birth outcomes	8
Sleep disturbance	4	Environmental noise interventions	9
Hearing impairment/tinnitus	5	Methodology and guideline development	10

Name	Position and affiliation	Area of expertise sought for guideline development (see reference numbers above)									
		1	2	3	4	5	6	7	8	9	10
Kerstin Persson Waye	Professor Occupational and Environmental Medicine The Sahlgrenska Academy University of Gothenburg Sweden	X			X		X				
Anna Preis	Professor Institute of Acoustics Adam Michiewicz University Poland					X	X				
Stephen Stansfeld (Chair)	Professor/Head of the Centre for Psychiatry Barts and Queen Mary University of London United Kingdom							X			
Martin van den Berg	Senior Noise Expert Ministry of Infrastructure and Environment Netherlands	X									
GRADE methodologist											
Jos Verbeek	Senior Researcher Finnish Institute of Occupational Health Finland	X									

Table A1.3. Systematic Review Team

Systematic review topics	Experts involved	Affiliation
Cardiovascular and metabolic diseases	Elise van Kempen	National Institute of Public Health and the Environment (RIVM), Netherlands
	Göran Pershagen	Institute of Environmental Medicine, Karolinska Institute, Sweden
	Maribel Casas Sanahuja	Institute for Global Health (ISGlobal), Spain
	Maria Foraster	Barcelona Institute for Global Health (ISGlobal), Spain and Swiss Tropical and Public Health Institute, Switzerland
Sleep disturbance	Mathias Basner	Department of Psychiatry, Perelman School of Medicine at the University of Pennsylvania, United States of America
	Sarah McGuire	Department of Psychiatry, Perelman School of Medicine at the University of Pennsylvania, United States of America
Hearing impairment and tinnitus	Mariola Sliwinska-Kowalska	Nofer Institute of Occupational Medicine, Poland
	Kamil Rafal Zaborowski	Nofer Institute of Occupational Medicine, Poland
Annoyance	Rainer Guski	Department of Psychology, Ruhr-University, Germany
	Dirk Schreckenberg	ZEUS GmbH, Centre for Applied Psychology, Environmental and Social Research, Germany
	Rudolf Schuemer	Consultant for ZEUS GmbH, Centre for Applied Psychology, Environmental and Social Research, Germany
Cognitive impairment, mental health and well-being	Charlotte Clark	Ove Arup & Partners, United Kingdom
	Katarina Paunovic	Institute of Hygiene and Medical Ecology, Faculty of Medicine, University of Belgrade, Serbia
Adverse birth outcomes	Mark Nieuwenhuijsen	Institute for Global Health (ISGlobal), Spain
	Gordana Ristovska	Institute of Public Health of Republic of Macedonia, the former Yugoslav Republic of Macedonia
	Payam Dadvand	Institute for Global Health (ISGlobal), Spain
Interventions	Lex Brown	Griffith School of Environment/Urban Research Program, Griffith University, Australia
	Irene Van Kamp	National Institute of Public Health and the Environment (RIVM), Netherlands

Table A1.4. External Review Group

Area of expertise	Reference	Area of expertise	Reference
Cardiovascular and metabolic diseases	1	Cognitive impairment, mental health and well-being	5
Sleep disturbance	2	Adverse birth outcomes	6
Hearing impairment/ Tinnitus	3	Environmental noise interventions	7
Annoyance	4	Recommendations and implementation guidance	8

Name	Affiliation	Area of expertise sought for guideline development (see reference numbers above)							
		1	2	3	4	5	6	7	8
Gunn Marit Aasvang	Norwegian Institute of Public Health, Norway		X						
Bernard Berry	Berry Environmental Limited, United Kingdom							X	
Dick Botteldooren	Department of Information Technology, Ghent University, Belgium				X				
Stephen Conaty	South Western Sydney Local Health District, Australia								X
Ulrike Gehring	Institute for Risk Assessment Sciences, Utrecht University, Netherlands						X		
Truls Gjestland	SINTEF, Department of Acoustics, Norway				X				
Mireille Guay	Healthy Environments and Consumer Safety Branch, Health Canada/Government of Canada, Canada		X		X				
Ayse Güven	Audiology Department, Faculty of Heath Sciences, Baskent University, Turkey			X					
Anna Hansell	Centre for Environmental Health & Sustainability, George Davies Centre, University of Leicester, United Kingdom	X							X
Stylianos Kephalopoulos	European Commission, DG Joint Research Centre, Italy							X	X
Yvonne de Kluizenaar	The Netherlands Organization for applied scientific research (TNO), Netherlands							X	
David S. Michaud	Healthy Environments and Consumer Safety Branch, Health Canada/Government of Canada, Canada		X		X				
Arnaud Norena	Université Aix-Marseille, Fédération de Recherche, Laboratoire Cognitive Neuroscience, France			X					
Enembe Okokon	National Institute for Health and Welfare, Finland								X
Dieter Schwela	Stockholm Environment Institute, University of York, United Kingdom								X
Daniel Shepherd	AUT University, Auckland, New Zealand					X			
Mette Sörensen	Danish Cancer Society Research Centre, Denmark	X							X
Rupert Thornley-Taylor	Rupert Taylor Ltd, Noise and Vibration Consultants							X	X
David Welch	School of Population Health, Faculty of Medical and Health Sciences, University of Auckland, New Zealand			X				X	

Table A1.5. Stakeholders and end users that participated in the stakeholder consultation

Area of expertise/interest	Reference	Area of expertise	Reference
Implementation of recommendations on railway noise	1	Implementation of recommendations on wind turbine noise	4
Implementation of recommendations on aircraft noise	2	Implementation of recommendations on leisure noise	5
Implementation of recommendations on road traffic noise	3	Implementation of overall recommendations	6

Organization	Area of expertise specifically sought for Guidelines (see reference number above)					
	1	2	3	4	5	6
Airlines for Europe		X				
Airports Council International Europe (ACI)		X				
Anderson Acoustics		X				
Bundesverband der Deutschen Luftverkehrswirtschaft e.V.		X				
European Automobile Manufacturers' Association (ACEA)			X			
European Aviation Safety Agency		X				
European Express Association	X					
European Noise Barrier Federation						X
Flughafenverband (ADV)		X				
International Air Transport Association (IATA)		X				
International Civil Aviation Organization (ICAO)		X				
International Union of Railways	X					
Landesamt fuer Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen						X
Public Health Agency of Sweden						X
Stephen Turner Acoustics					X	X
Union Européenne Contre les Nuisances Aeriennes		X				
Vie en.ro.se.						X

Note: in total 53 organizations and institutions had been approached to participate in the stakeholder consultation.

Annex 2. Systematic reviews and background documents used in preparation of the guidelines

Annex 2 provides a detailed list of all the supplementary documents accompanying the WHO environmental noise guidelines for the European Region.[22]

Systematic reviews

- Basner M, McGuire S (2018). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and effects on sleep. Int J Environ Res Public Health. 15(3):pii: E519 (http://www.mdpi.com/1660-4601/15/3/519/htm).
- Brown AL, van Kamp I (2017). WHO environmental noise guidelines for the European Region: a systematic review of transport noise interventions and their impacts on health. Int J Environ Res Public Health. 14(8). pii: E873 (http://www.mdpi.com/1660-4601/14/8/873/htm).
- Clark C, Paunovic K (2018). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and cognition. Int J Environ Res Public Health. 15(2). pii: E285 (http://www.mdpi.com/1660-4601/15/2/285/htm).
- Clark C, Paunovic K (in press). WHO Environmental noise guidelines for the European Region: a systematic review on environmental noise and quality of life, wellbeing and mental health. Int J Environ Res Public Health.
- Guski R, Schreckenberg D, Schuemer R (2017). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and annoyance. Int J Environ Res Public Health. 14(12). pii:1539 (http://www.mdpi.com/1660-4601/14/12/1539/htm).
- Nieuwenhuijsen MJ, Ristovska G, Dadvand P (2017). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and adverse birth outcomes. Int J Environ Res Public Health. 14(10). pii: E1252 (http://www.mdpi.com/1660-4601/14/10/1252/htm).
- Śliwińska-Kowalska M, Zaborowski K (2017). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and permanent hearing loss and tinnitus. Int J Environ Res Public Health. 14(10). pii: E1139 (http://www.mdpi.com/1660-4601/14/10/1139/htm).
- van Kempen E, Casas M, Pershagen G, Foraster M (2018). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and cardiovascular and metabolic effects: a summary. Int J Environ Res Public Health. 15(2). pii: E379 (http://www.mdpi.com/1660-4601/15/2/379/htm).

[22] All references were accessed on 27 June 2018.

Background documents

- Eriksson C, Pershagen G, Nilsson M (2018). Biological mechanisms related to cardiovascular and metabolic effects by environmental noise. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/biological-mechanisms-related-to-cardiovascular-and-metabolic-effects-by-environmental-noise).
- Héroux ME, Verbeek J (2018a). Results from the search for available systematic reviews and meta-analyses on environmental noise. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/results-search-for-available-systematic-reviews-environmental-noise).
- Héroux ME, Verbeek J (2018b). Methodology for systematic evidence reviews for the WHO environmental noise guidelines for the European Region. Copenhagen: WHO Regional Office for Europe (http://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/methodology-systematic-evidence-reviews-who-environmental-guidelines-for-the-european-region).

Annex 3. Summary of conflict of interest management

All external contributors to the guidelines, including members of the GDG, Systematic Review Team and External Review Group, completed WHO declaration of interest forms in accordance with WHO's policy for experts. Further, at the initial stage of the project WHO technical staff reviewed and accepted *curricula vitae* of the candidates for the GDG.

At the beginning of the GDG meetings, the participants declared any conflict of interest by submitting declaration of interest forms. Updated declarations of interest were also collected from the members of the GDG, Systematic Review Team and External Review Group at the final stage of the project.

The conflict of interest assessment was done according to WHO procedures. If a conflict was declared, an initial review was undertaken by the WHO Secretariat to assess its relevance and significance. A declared conflict of interest is insignificant or minimal if it is unlikely to affect or to be reasonably perceived to affect the expert's judgment. Insignificant or minimal interests are: unrelated or only tangentially related to the subject of the activity or work and its outcome; nominal in amount or inconsequential in importance; or expired and unlikely to affect current behaviour.

The WHO Secretariat reviewed and assessed the declarations. In one case the legal unit was consulted for advice; in another the potential conflict was reported in the updated declaration of interest at the final stage of the process and assessed unlikely to affect expert's performance; in a further case a member of the GDG was also a co-author of a systematic review owing to the need to support systematic review authors with additional expertise, but there was no remuneration for this activity.

No member of the GDG or the Systematic Review Team was excluded from his or her role in the guideline development process. The declared conflicts of interest of the External Review Group members were considered when interpreting comments during the external review process.

Annex 4. Detailed overview of the evidence of important health outcomes

As a first step of the evidence retrieval process, the GDG defined two categories of health outcome associated with environmental noise: those considered (i) critical or (ii) important, but not critical for decision-making in the guideline development process.

The GDG relied on the critical health outcomes to inform its decisions on priority health outcomes, so only these were used to inform the recommendations. Nevertheless, as the relevance of some of important health outcomes was difficult to estimate *a priori,* systematic reviews were conducted for both critical and important health outcomes.

This annex provides a detailed overview of the evidence of the important health outcomes – namely adverse birth outcomes, quality of life, well-being and mental health and metabolic outcomes – for each of the noise sources. A comprehensive discussion of all the evidence considered (both critical and important) is available in the published systematic reviews (see section 2.3.2 and Annex 2 for details).

1. Road traffic noise

1.1 Adverse birth outcomes

In total, the systematic review found five studies (two with more or less the same population) on road traffic noise and birth outcomes and three related studies on total ambient noise, likely to be mostly road traffic noise. Too few studies for each of the various measures related to adverse birth outcomes were available to undertake a quantitative meta-analysis. There was evidence rated low quality for a relationship between road traffic noise and low birth weight (Dadvand et al., 2014; Gehring et al., 2014; Hjortebjerg et al., 2016; Wu et al., 1996); however, the estimates were imprecise and in some cases not statistically significant. Further, there was no clear relation between exposure to road traffic noise and pre-term delivery, but there was a positive association between road traffic noise and small for gestational age (OR = 1.09; 95% CI: 1.06–1.12 per 6 dB increase). The evidence for both measures of adverse birth outcomes comes from the same publications and this evidence was rated low quality (Gehring et al., 2014; Hystad et al., 2014).

This evidence was supported by one ecological time-series study published recently looking at total ambient noise and various measures related to adverse birth outcomes (Arroyo et al., 2016a; 2016b; Diaz et al., 2016).

1.2 Quality of life, well-being and mental health

Evidence rated moderate quality was found for an effect of road traffic noise on emotional and conduct disorders in childhood (Belojevic et al., 2012; Crombie et al., 2011; Hjortebjerg et al., 2015; Ristovska et al., 2004; Stansfeld et al., 2005; 2009a; Tiesler et al., 2013) and evidence rated moderate quality for an association of road traffic noise with hyperactivity in children (Hjortebjerg et al., 2015; Tiesler et al., 2013).

There was no clear relationship, however, between road traffic noise exposure and self-reported quality of life (evidence rated low quality) (Barcelo Perez & Piñeiro, 2008; Brink, 2011; Clark et al., 2012; Honold et al., 2012; Roswall et al., 2015; Schreckenberg et al., 2010b; Stansfeld et al., 2005; 2009b; van Kempen et al., 2010); medication intake for depression and anxiety (evidence rated very low quality) (Floud et al., 2011; Halonen et al., 2014); depression, anxiety and psychological distress (evidence rated very low quality) (Honold et al., 2012; Stansfeld et al., 2009b); and interview measures of depression and anxiety (evidence rated very low quality) (Stansfeld et al., 2009b).

1.3 Metabolic outcomes

1.3.1 Diabetes

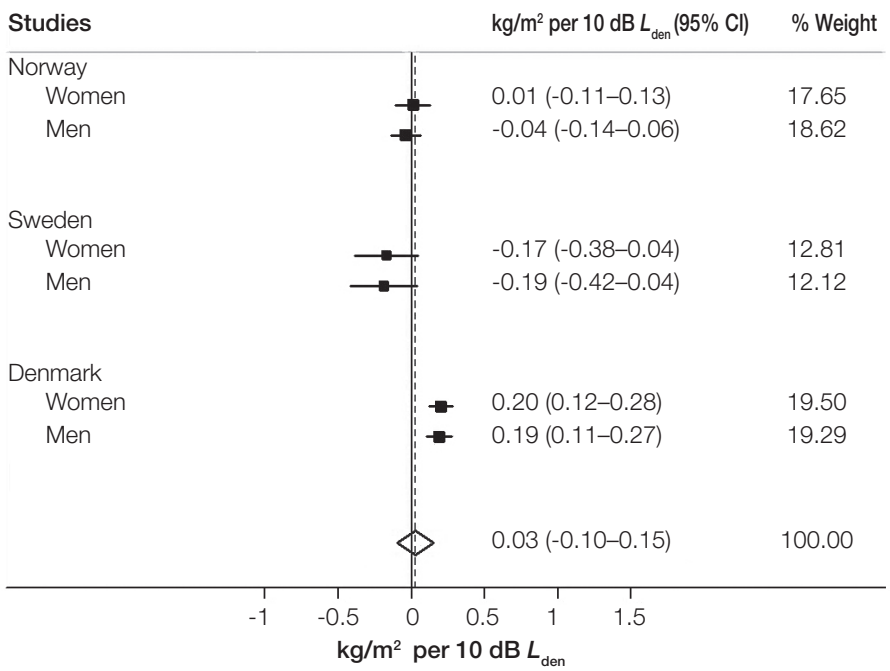
For the relationship between road traffic noise and the incidence of diabetes, one cohort study was identified, which included 57 053 participants and 2752 cases (Sörensen et al., 2013). The estimate of the effect was RR = 1.08 (95% CI: 1.02–1.14) per 10 dB L_{den} increase in noise across the range of 50–70 dB, and therefore the evidence was rated moderate quality.

Furthermore, two cross-sectional studies were identified that looked at the prevalence of diabetes (Selander et al., 2009; van Poll et al., 2014). The studies included 11 460 participants and 242 cases. Both studies reported a harmful effect of noise, and one showed a statistically significant association. However, the results were imprecise and with serious risk of bias, so the evidence was rated very low quality.

1.3.2 Obesity

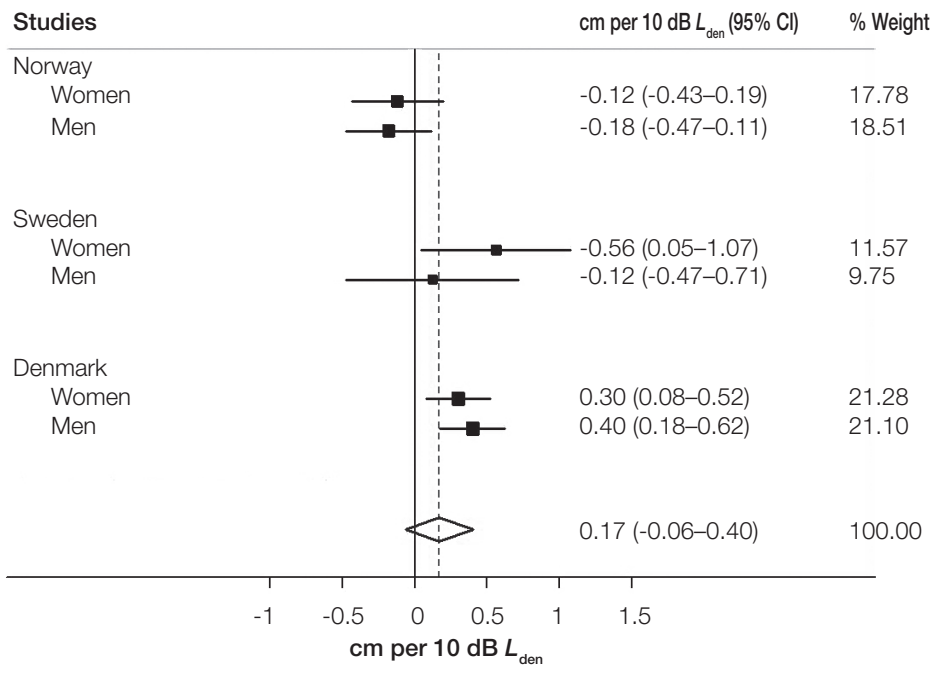
With regard to the association between road traffic noise and change in body mass index (BMI) and waist circumference, three cross-sectional studies were identified, with 71 431 participants (Christensen et al., 2016; Oftedal et al., 2014; 2015; Pyko et al., 2015). For each 10 dB increase in road traffic noise, there was a statistically nonsignificant increase in BMI of 0.03 kg/m^2 (95% CI: –0.10–0.15 kg/m^2) and in waist circumference of 0.17 cm (95% CI: –0.06–0.40 cm). There was inconsistency in the results between the studies; therefore, for both associations, the evidence was rated very low quality (Fig. A4.1 and Fig. A4.2).

Fig. A4.1 The association between exposure to road traffic noise (L_{den}) and BMI in three Nordic studies



Notes: The black vertical line corresponds to no effect of noise exposure. The black dots correspond to the estimated slope coefficients per 10 dB for each sex in each study, with 95% CIs. The diamond designates summary estimates and 95% CIs based on random effects models. The dashed red line corresponds to these summary estimates. Heterogeneity between studies: p = 0.000; heterogeneity between genders: p = 0.360; overall (I-squared = 84.4%, p = 0.000). Weights are from random effect analysis.

Fig. A4.2 The association between exposure to road traffic noise (L_{den}) and waist circumference in three Nordic studies



Notes: The black vertical line corresponds to no effect of noise exposure. The black dots correspond to the estimated slope coefficients per 10 dB for each sex in each study, with 95% CIs. The diamond designates summary estimates and 95% CIs based on random effects models. The dashed red line corresponds to these summary estimates. Heterogeneity between studies: p = 0.001; heterogeneity between genders: p = 0.842; overall (I-squared = 69.0%, p = 0.007). Weights are from random effect analysis.

2. Railway noise

2.1 Adverse birth outcomes

No studies were found, and therefore no evidence was available on the association between railway noise and adverse birth outcomes.

2.2 Quality of life, well-being and mental health

Evidence rated very low quality was found for a weak effect of railway noise exposure on self-reported quality of life or health, albeit from a limited number of studies (Roswall et al., 2015; Torre et al., 2007). There was evidence rated moderate quality for an effect of railway noise on emotional and conduct disorders in childhood (Hjortebjerg et al., 2015), but no clear relationship between railway noise and children's hyperactivity (Hjortebjerg et al., 2015); this evidence was rated moderate quality.

2.3 Metabolic outcomes

2.3.1 Diabetes

One cohort study was identified that looked at the relationship between railway noise and the incidence of diabetes (Sörensen et al., 2013). The cohort study of 57 053 participants, including 2752 cases, found evidence rated moderate quality that there was no considerable effect of railway noise on diabetes, with an RR of 0.97 (95% CI: 0.89–1.05) per 10 dB L_{den} increase in noise.

Furthermore, one cross-sectional study was identified that looked at the relationship between railway noise and the prevalence of diabetes (van Poll et al., 2014), including 9365 participants and 89 cases. An RR of 0.21 (95% CI: 0.05–0.82) per 10 dB L_{den} increase in noise was found, but the reasons for the beneficial effect were not immediately apparent. The evidence in the study was rated very low quality.

2.3.2 Obesity

Regarding the association between railway noise and change in BMI and waist circumference, two cross-sectional studies were identified, with 57 531 participants (Christensen et al., 2016; Pyko et al., 2015). Christensen and colleagues observed a statistically significant increase of 0.18 kg/m^2 (95% CI: 0.00–0.36 kg/m^2) per 10 dB for BMI and 0.62 cm (95% CI: 0.14–1.09 cm) per 10 dB for waist circumference in those exposed to railway noise, at levels above 60 dB L_{den}. Pyko and colleagues found a statistically significant increase in waist circumference of 0.92 cm (95% CI: 0.06–1.78 cm) per 10 dB L_{den}. The corresponding estimate for BMI was statistically nonsignificant, at 0.06 kg/m^2 (95% CI: –0.02–0.16 kg/m^2). The evidence was rated low/very low quality.

3. Aircraft noise

3.1 Adverse birth outcomes

Evidence rated very low quality was available for an association between aircraft noise and pre-term delivery, low birth weight and congenital anomalies, as evidenced by six studies included in the systematic review (Ando & Hattori, 1973; Edmonds et al., 1979; Jones & Tauscher, 1978; Knipschild et al., 1981; Matsui et al., 2003; Schell, 1981). The potential for risk of bias in these was high and the results tended to be inconsistent.

3.2 Quality of life, well-being and mental health

Evidence rated very low quality was available for an effect of aircraft noise on medication intake for depression and anxiety (Floud et al., 2011). There was evidence rated very low quality for an effect of aircraft noise exposure on interview measures of depression and anxiety (Hardoy et al., 2005) and rated low quality for an association of aircraft noise with hyperactivity in children (Clark et al., 2013; Crombie et al., 2011; Stansfeld et al., 2009a).

The evidence showed, however, no substantial effect of aircraft noise on self-reported quality of life or health (Clark et al., 2012; Schreckenberg et al., 2010a; 2010b; Stansfeld et al., 2005; van Kempen et al., 2010) or on emotional and conduct disorders in childhood (Clark et al., 2012; 2013; Crombie et al., 2011; Stansfeld et al., 2005; 2009a). This evidence was rated very low quality.

3.3 Metabolic outcomes

3.3.1 Diabetes

For the relationship between aircraft noise and incidence of diabetes one cohort study was identified, including 5156 participants and 1346 cases (Eriksson et al., 2014). The estimate of the effect was imprecise, with an RR of 0.99 (95% CI: 0.47–2.09) per 10 dB L_{den} increase in noise; the evidence was therefore rated very low quality.

Furthermore, one cross-sectional study was identified that looked at the prevalence of diabetes (van Poll et al., 2014), including 9365 participants and 89 cases. The RR was 1.01 (95% CI: 0.78–1.31) per 10 dB increase in aircraft noise. The evidence was rated very low quality.

3.3.2 Obesity

For the association between aircraft noise and change in BMI and waist circumference, one cohort study was identified, with 5156 participants (Eriksson et al., 2014). For each 10 dB increase in aircraft noise level, the increase in BMI was 0.14 kg/m^2 (95% CI: –0.18–0.45) (evidence rated low quality), and the increase in waist circumference was 3.46 cm (95% CI: 2.13–4.77) (evidence rated moderate quality). The range of noise levels in the study was 48–65 dB L_{den}. In the case of BMI, the change over the whole range in noise values was not statistically significant and was less than what could be considered clinically relevant (3–5% change in BMI); however, for waist circumference, the change was equivalent to an increase of 5.8 cm.

4. Wind turbine noise

4.1 Quality of life, well-being and mental health

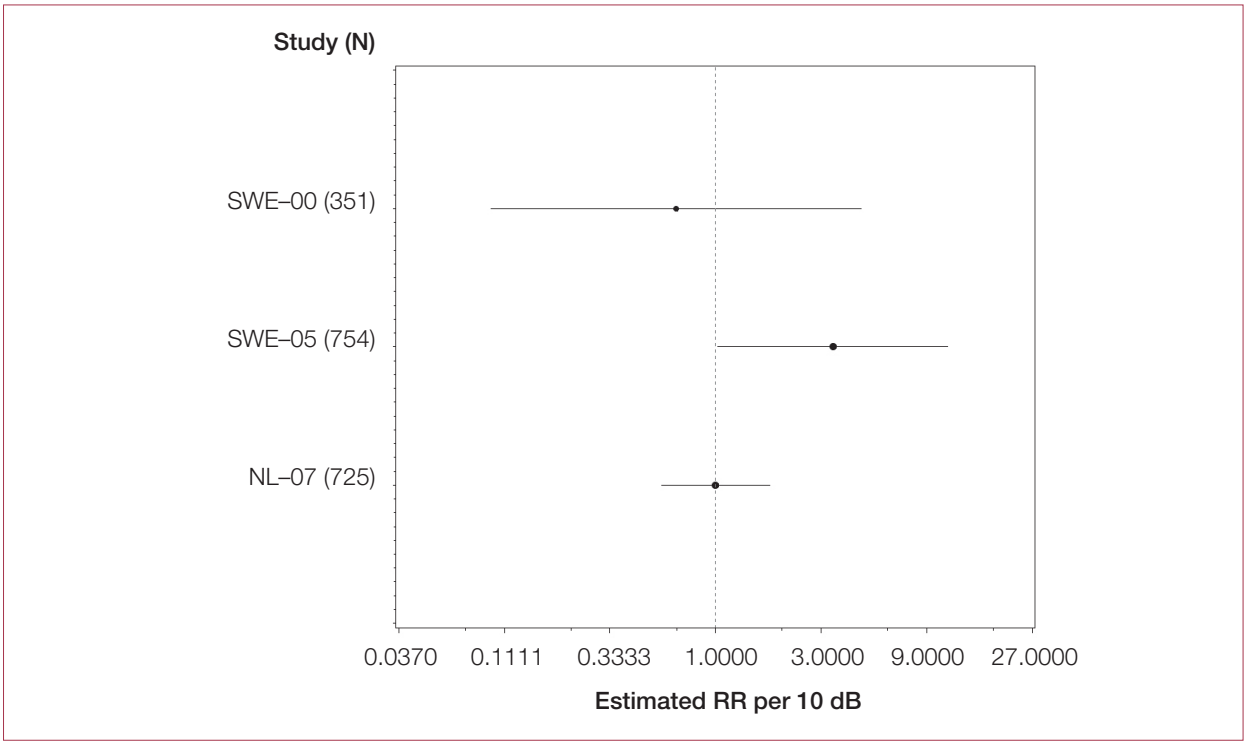
Five low-quality systematic reviews of wind turbine noise effects on mental health and well-being have been carried out (Ellenbogen et al., 2012; Kurpas et al., 2013; Merlin et al., 2013; Onakpoya et al., 2015; Schmidt & Klokker, 2014). These reviews differed in their conclusions and delivered inconsistent evidence that wind turbine noise exposure is associated with poorer quality of life, well-being and mental health. Therefore, the evidence for no substantial effect of wind turbine noise on quality of life, well-being or mental health was rated very low quality.

4.2 Metabolic outcomes

4.2.1 Diabetes

For the relationship between wind turbine noise and prevalence of diabetes, three cross-sectional studies were identified, with a total of 1830 participants (Bakker et al., 2012; Pedersen, 2011; Pedersen & Larsman, 2008; Pedersen & Persson Waye, 2004; 2007; Pedersen et al., 2009; van den Berg et al., 2008). The number of cases was not reported. The effect sizes varied across studies, and only one study found a positive association between exposure to wind turbine noise and the prevalence of diabetes; therefore, no meta-analysis was performed. Due to very serious risk of bias and imprecision in the results, this evidence was rated very low quality. As a result, there is no clear relationship between audible noise (greater than 20 Hz) from wind turbines or wind farms and prevalence of diabetes (Fig. A4.3).

Fig. A4.3 The association between exposure to wind turbine noise (sound pressure level) and self-reported diabetes



Note: The dotted vertical line corresponds to no effect of exposure to wind turbine noise. The black circles correspond to the estimated RR per 10 dB (sound pressure level) and 95% CI.
For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

5. Leisure noise

Owing to a lack of evidence meeting the critieria for systematic reviewing, no results for any of the important health outcomes can be given for exposure to leisure noise.

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The WHO Regional Office for Europe

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Europe is one of six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

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Noise is an important public health issue. It has negative impacts on human health and well-being and is a growing concern. The WHO Regional Office for Europe has developed these guidelines, based on the growing understanding of these health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. They provide robust public health advice underpinned by evidence, which is essential to drive policy action that will protect communities from the adverse effects of noise. The guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience.

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Community Health and Airport Operations Related Noise and Air Pollution: Report to the Legislature in Response to Washington State HOUSE BILL 1109

December 1, 2020

Public Health
Seattle & King County

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EXECUTIVE SUMMARY

This report responds to a proviso in Washington state's House Bill 1109 which requests that Public Health – Seattle & King County produce a) airport community health profiles for a one-mile, a five-mile, and a 10-mile radius of the airport; b) a comprehensive literature review assessing the strength-of-evidence for health effects of airport operations; c) a summary of findings of the University of Washington School of Public Health study on ultrafine particulate matter; and d) recommendations to address health issues related to the impact of the airport on the community. The purpose is to understand the community health effects of pollution related to Seattle-Tacoma International Airport (SeaTac) operations.

WHAT IS THE HEALTH OF AIRPORT COMMUNITIES COMPARED TO THE REST OF KING COUNTY?

The majority of people in King County identifying as Black/African American, Hispanic/Latino, and Native Hawaiian/Pacific Islander live in communities within 10 miles of the airport (hereafter referred to as airport communities). A greater proportion of people in these communities are immigrants, and a slightly higher proportion are children, compared to elsewhere in the county.

People living within 10 miles of SeaTac airport face disparities in health, resources, and risk factors compared to the rest of the county. They were significantly more likely to be living below 200% of the federal poverty level, to not receive needed medical care due to the cost, and not to have health insurance compared to the remainder of King County. They were also more likely to have risk factors that increase their vulnerability to more serious health outcomes, such as a higher prevalence of smoking, obesity, physical inactivity and high blood pressure. A greater percentage of adults in airport communities than elsewhere in the county reported inadequate amounts of sleep.

Airport communities are associated with higher rates of pervasive health concerns. Compared to the rest of the county, communities within 10 miles of SeaTac report:

- A greater percentage of infants born prematurely and/or with low birthweight;
- Higher hospitalization rates for asthma, stroke, chronic obstructive pulmonary disease (COPD), heart disease, and diabetes;
- Lower life expectancy; and
- Higher rates of death overall, as well as death from heart disease, unintentional injury, chronic lower respiratory disease, diabetes, chronic liver disease, and homicide.

In several measures, the rates of poor health outcomes were worse the closer you are to the airport. For example:

- Higher hospitalization rates for heart disease;
- Higher rate of death from all causes;
- Higher rate of death from heart disease; and
- Lower life expectancy.

This examination of community health is a snapshot of health conditions experienced by people living within 10 miles of SeaTac airport. Findings demonstrate that disparities are present throughout the life course, beginning at birth.

WHAT POLLUTANTS RESULT FROM AIRPORT OPERATIONS AND WHAT ARE THE LIKELY HEALTH IMPACTS?

Airport operations result in noise and air pollution, which are linked to many of the health outcomes experienced by airport communities. Noise pollution contributes to hypertension and heart disease and likely causes poor school performance among children. Air pollution impacts numerous organ systems, and multiple pollutants are associated with cardiovascular and respiratory problems. The air pollutants

related to airport operations include particulate matter of various sizes, ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur oxides (SO_x), and other hazardous air pollutants. Fine particulate matter ($PM_{2.5}$) causes cardiovascular and respiratory problems, and likely causes cancer and central nervous system conditions, including dementia and neurodegeneration. Existing research is less conclusive about larger and smaller particulate matter in comparison, though recent studies link exposure to increased risk of preterm births and respiratory concerns, among other issues. Ozone, NO_2, and SO_x cause short-term respiratory issues. NO_2 likely causes long-term cardiovascular problems, and CO causes short-term cardiovascular concerns and likely affects lung functioning.

These pollutants are especially concerning for people with underlying respiratory or cardiovascular issues because they worsen existing conditions, though long-term exposures increase risk in the general population for developing problems. The hazardous air pollutants (HAPs) found at airports are known or suspected carcinogens and/or cause birth defects. Lead exposures are more common at Boeing Field, Renton, and Auburn airports than at SeaTac airport, because small planes with piston engines still use leaded gasoline. Lead causes central nervous system problems and is damaging even at low levels; thus it is worth mentioning despite lower prevalence at SeaTac airport. Noise and air pollution have been documented near SeaTac as well as other airports at levels higher than recommended for population health.

WHAT WERE FINDINGS FROM THE UNIVERSITY OF WASHINGTON PUBLIC HEALTH STUDY OF ULTRA-FINE PARTICULATES?

Researchers with University of Washington's Environmental and Occupational Health Sciences Department conducted the first study of ultrafine particle (UFP) concentrations near the SeaTac airport during 2018–19 and found higher concentrations of UFP below aircraft flight paths, with the highest concentrations associated with aircraft landings. Pollution near roadways showed high concentrations of UFP and black carbon. Findings support the conclusion that communities underneath and downwind of the flight path are exposed to aircraft-related UFP concentrations.

RECOMMENDATIONS TO ADDRESS HEALTH ISSUES

Prevention and mitigation of airport-related pollution exposures is critical for these communities, given their increased risk. People living in airport communities are more likely to be exposed to airport-related air and noise pollution. They are more likely to have underlying conditions like diabetes, heart disease, and respiratory conditions, which increases vulnerability to more serious health outcomes resulting from pollution exposures. Epigenetic changes from exposures to previous generations may increase susceptibility to health effects from air pollution today.

To address the health disparities of airport communities, we recommend the following:

- Implement focused efforts to address the health disparities of airport communities, including mitigating the health impacts of airport operations.
- Continue development and implementation of strategies to mitigate airport-related air and noise pollution.
- Expand the systematic monitoring of pollutants (both outdoor and indoor exposures) in residences, schools, childcare settings, and long-term care facilities, including the implementation of new technologies to improve measurement of exposures indoors and outdoors.
- Support research to address gaps in knowledge, including the levels of pollutant exposure resulting from airport operations, the extent to which outside pollutants infiltrate indoor settings, and the precise mechanisms and degree of harm caused by air and noise pollution.

I. INTRODUCTION

Washington State sought to better understand the community health effects of pollution related to Seattle-Tacoma International Airport operations. The legislature thus included the following proviso in HOUSE BILL 1109 for the Washington State operating budget.[1]

a) $62,000 of the general fund – state appropriation for fiscal year 2020 and $63,000 of the general fund – state appropriation for fiscal year 2021 are provided solely for the King County local health jurisdiction, as part of the foundational public health services, to conduct a study on the population health impact of the SeaTac airport communities.
b) By December 1, 2020, the King County local health jurisdiction shall submit a report to the appropriate committees of the legislature that must include:
    i. An analysis of existing data sources and an oversample of the Best Start for Kids child health survey to produce airport community health profiles within a one-mile, five-mile, and ten-mile radius of the airport;
    ii. A comprehensive literature review concerning the community health effects of airport operations, including a strength-of-evidence analysis;
    iii. The findings of the University of Washington School of Public Health study on ultrafine particulate matter at the airport and surrounding areas; and
    iv. Any recommendations to address health issues related to the impact of the airport on the community.

This report summarizes findings from these efforts. The following section reviews community health profiles for communities within radii of one, five, and 10 miles from the airport. The purpose of the community health profiles is to describe the communities proximal to the airport to understand their health. The next section summarizes findings from the literature review, including background information about airport operations and key pollutants; strength-of-evidence methods and findings; evidence of relevant, effective mitigation efforts; and a summary of findings from the University of Washington study on ultrafine particulate matter. The report concludes with recommendations based on the community health profiles and a review of the evidence to date.

II. WHAT IS THE HEALTH OF AIRPORT COMMUNITIES COMPARED TO THE REST OF KING COUNTY?

Report requirement 1: Community health profiles by distance from airport

> Proviso language: An analysis of existing data sources and an oversample of the Best Start for Kids child health survey to produce airport community health profiles within a one mile, five mile, and ten mile radius of the airport

A. SUMMARY

The community health profiles of areas one, five, and 10 miles from SeaTac airport (Zones A, B, and C) describe disparities in health experienced in airport communities compared to elsewhere in King County. A majority of the people in King County identifying as Black/African American, Hispanic/Latino, and Native Hawaiian/Pacific Islander live within 10 miles of the airport. In comparison with the Balance of County (the non-overlapping areas of the county beyond 10 miles of the airport), people living in airport communities are disproportionately more likely to experience poor health and less access to resources. For example:

- Between 34% and 51% of children were living at less than 200% of the federal poverty level, compared to 15% of children in Balance of County.
- The percent of adults with no health insurance in Zones A and B was more than twice the rate in Balance of County.
- Hospitalization rates for asthma, stroke, diabetes, and heart disease were higher in airport communities than in Balance of County.
- Life expectancy was between 1.7 and 5.0 years lower than that of Balance of County and decreased the closer you are to the airport.
- Residents of airport communities had higher rates of death by heart disease, unintentional injury, chronic lower respiratory disease, diabetes, chronic liver disease, and homicide than did people in Balance of County.

Many of these conditions have been linked in the literature to airport-related air and noise pollution. These include preterm births, depression, high blood pressure, and hospitalizations for asthma, heart disease, COPD, and stroke.

A greater percentage of adults in Zones B and C reported inadequate amounts of sleep compared to Balance of County. Parents/caregivers of children in elementary school or younger living in airport communities had inadequate sleep amounts similar to those of others in the rest of the county. Results differ from the prior measure, and this is likely due to the difference in who was asked, as these results are from parents/caregivers of younger children and not adults of all ages.

An analysis of excess deaths examined how many fewer deaths would occur if the communities near the airport had the same risk of death as Balance of County. Across four of the leading causes of death in the county (heart disease, cancer, unintentional injuries, and stroke), the number of deaths in airport communities exceeded the expected number of deaths if airport communities had the same death rates as the Balance of County. The closer you are to the airport, the higher the number of excess deaths associated with these causes.

A community asset not reflected in the current population health data is the robust community organization and advocacy in support of environmental justice that exists in airport communities. People living in airport communities are acutely aware of the data and evidence regarding air and noise

pollution and actively advocate for decisions that lead to healthy and safe environments (see, for example, the Duwamish River Cleanup Coalition and the Beacon Hill Seattle Noise Team).

The following profiles are descriptive and cannot be linked to specific causes. Findings demonstrate, however, that disparities are present throughout the life course, beginning at birth.

B. COMMUNITY HEALTH PROFILE METHODS

To understand the health of communities near SeaTac airport, we analyzed data from multiple sources. These include:

- Washington State Department of Health's Community Health Assessment Tool (CHAT), a repository of population health information including birth, hospitalization, and death data;
- The U.S. Census Bureau's annual American Community Survey;
- King County Best Starts for Kids Health Survey of parents/caregivers of infants and young children through fifth grade;
- Washington State's Healthy Youth Survey of eighth-, 10th- and 12th-grade students in public schools;
- Washington State Department of Health's Behavioral Risk Factor Surveillance System survey of adults; and
- Education measures for K–12 students from Washington State's Office of the Superintendent of Public Instruction.

The following tables and text compare rates in Zones A, B, and C to Balance of County using the following definitions (Figure 1):

- Zone A: <1 mile from airport;
- Zone B: 1 to <5 miles from airport;
- Zone C: 5 to 10 miles from airport;
- Airport communities: Zones A, B, and C combined; and
- Balance of County: the area in King County more than 10 miles from the airport (the comparison area).

The zones overlap the census tract areas with the greatest average number of flights per day based on 2018 SeaTac flight data (Appendix A, Figure A1).

Appendix A reviews information for specific measures and methods of analysis. King County averages for all measures except excess deaths analysis are in Appendix B. Differences were considered statistically significant when 95% confidence intervals for rates compared did not overlap. Statistically significant differences are denoted in tables and text as the following:

- "Higher" means statistically significantly higher than Balance of County.
- "Lower" means statistically significantly lower than Balance of County.
- "Not different" means the difference from Balance of County was not statistically significant.

A difference that was not statistically significant is noted as a finding that "appeared" higher or lower.

Figure 1
Community Health Profile Zones

C. COMMUNITY HEALTH PROFILE FINDINGS

1. Demographic Characteristics

Key points:

- Nearly three-quarters of people in King County who identify as Black/African American live in airport communities. Similarly, 74.8% of the county's Native Hawaiian and Pacific Islanders, 57.6% of the county's Hispanic/Latino, and nearly half of the county's Asian population call the areas within 10 miles of the airport home.
- Compared to elsewhere in King County, airport communities (Zones A, B, and C) have a higher percentage of the population living in near poverty or poverty (up to 200% of the federal poverty level).
- Children in third grade in airport communities are less likely to have met third-grade reading standards; the on-time high school graduation rate was lower in the airport communities than in Balance of County.

Population totals and age: The average 2014–18 estimated population was 30,319 in Zone A, 260,163 in Zone B, and 605,546 in Zone C. Combined, the airport communities represent 42.6% of the county's population. The total Balance of County population is about 1.2 million, or 57.4% of King County.

The population distribution by age of residents was similar in airport communities and Balance of County with two exceptions (Table 1). The percentage of children living in the airport communities was slightly higher (between 22.8 and –3.1%) compared to Balance of County (19.5%). The percentage of adults 25–44 years of age was slightly lower; 29.5 and –32.1% of residents in airport communities were 25–44 years of age, compared to 33.9% in Balance of County.

Table 1

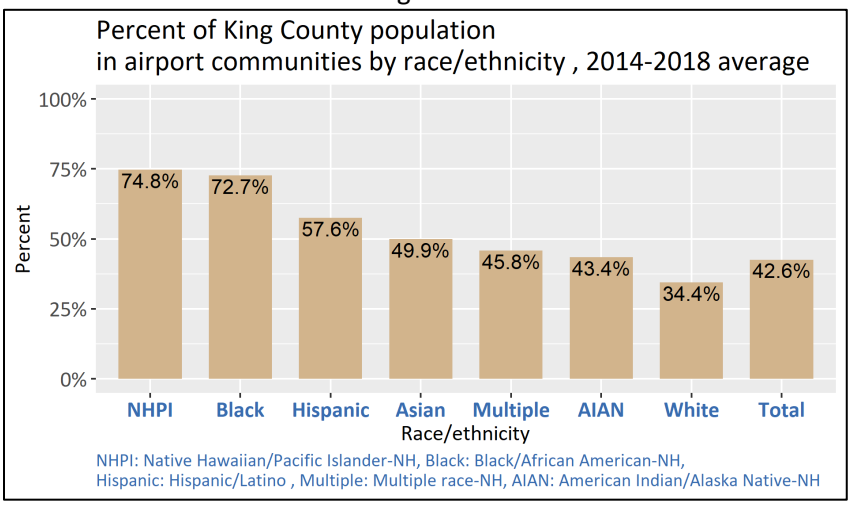
Population estimates by age group
by Zone, 2014-2018 annual average

Age	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County	
	Population	Percent	Population	Percent	Population	Percent	Population	Percent
Under 18	6,944	22.9%	60,202	23.1%	138,221	22.8%	235,712	19.5%
18 to 24	2,922	9.6%	22,250	8.6%	49,405	8.2%	111,731	9.3%
25 to 44	9,744	32.1%	79,124	30.4%	178,513	29.5%	409,925	33.9%
45 to 64	7,064	23.3%	65,759	25.3%	159,739	26.4%	306,420	25.4%
65 and over	3,645	12.0%	32,828	12.6%	79,668	13.2%	143,994	11.9%
Total	30,319	100.0%	260,163	100.0%	605,546	100.0%	1,207,782	100.0%

Race/ethnicity: The airport communities are home to the majority of King County's people of color (Figure 2). Roughly three-fourths (74.8%) of the county's Native Hawaiian/Pacific Islanders live in the airport communities. The majority of Black/African Americans (72.7%) and Hispanic/Latinos (57.6%) live in this area as well.

The percentage of the population identifying as Black/African American, Hispanic/Latino, or Native Hawaiian/Pacific Islander increased the closer you are to the airport (see Appendix B for data).

Figure 2



Foreign born: The percentage of people who were immigrants increased the closer you are to the airport (Table 3). Over one-third of Zone A residents (35.9%), 27.1% of Zone B, and 23.9% of Zone C residents were immigrants, compared to 20.5% of Balance of County residents. Place of birth for foreign-born individuals varied by zone; the highest percentage immigrated from Africa in Zone A and Asia in Zones B and C. The three most common regions of emigration (plus approximate counts and percent of total foreign-born) were:

- Zone A: Africa (4,200, 37%), Asia (3,500, 31%), Latin America (2,700, 23%);
- Zone B: Asia (34,200, 47%), Latin America (21,500, 30%), Africa (8,600, 12%);
- Zone C: Asia (81,700, 55%), Latin America (26,550, 18%), Europe (19,100, 13%).

Table 2

Foreign born
by Zone, 2014-2018 average

	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
Indicator	Percent	Count	Percent	Count	Percent	Count	Percent
Foreign born	**35.9%**	11,500	**27.1%**	72,600	**23.9%**	147,500	20.5%

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

Poverty and Near-Poverty: U.S. poverty thresholds define who is in poverty and are based on household income, the number of children, and family size.[i] A higher percentage of people lived in near poverty or poverty, defined as below 200% of the federal poverty level (FPL), in airport communities compared to Balance of County (Table 3). The percentage of people in near poverty or poverty increased the closer you are to the airport, ranging from 37.2% in Zone A to 16.1% in Balance of County.

Just over half of children in Zone A (51.1%) and 46.7% of children in Zone B (46.7%) were in near poverty and poverty. Just over one-third (33.5%) of children in Zone C were below 200% FPL, compared to 14.6% in Balance of County. The percentage of children living near-poverty or poverty in Zone A was over three times the rate in Balance of County.

[i] See https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html for thresholds.

Table 3

Poverty Income <200% of the Federal Poverty Level by Zone, 2014-2018 average[1]							
	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
Age	Percent	Count	Percent	Count	Percent	Count	Percent
Total	**37.2%**	11,500	**31.7%**	84,100	**24.4%**	148,800	16.1%
Under 18	**51.1%**	3,800	**46.7%**	27,800	**33.5%**	44,200	14.6%

[1] In 2020, income for a family of 4 at 200% of the Federal Poverty Level is $52,400.

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

Educational success (children): Children in third grade in Zones A (43.4%), B (39.0%), and C (54.6%) were less likely to have met the third-grade reading standard than their counterparts in Balance of County (73.3%; Table 4). The high school graduation rates for students in Zones A (80.7%), B (72.3%), and C (81.0%) were lower than the rate for Balance of County (87.7%).

Table 4

Child educational sucess by Zone, 2018-2019 school year				
	Zone A: <1 mile from airport	Zone B: 1 to <5 miles from airport	Zone C: 5 to 10 miles from airport	Balance of County
Indicator	Rate	Rate	Rate	Rate
Met 3rd grade reading standard	***43.4%***	***39.0%***	***54.6%***	73.3%
High school graduation rate[1]	***80.7%***	***72.3%***	***81.0%***	87.7%

[1] Graduation from high school within 4 years

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

Note: Counts were not available for this measure.

Educational attainment (adults): Nearly seven of 10 adults in Balance of County completed an associate degree or higher, more than twice the rate in Zone A (28.1%; Table 5). The rates in Zone B (38.6%) and C (51.4%) were also much lower than Balance of County. The percentage of adults with an associate degree or higher decreased with proximity to the airport. For adults, having a high school diploma or more education was also less common in the airport communities than in Balance of County (see Appendix B for data).

Table 5

Educational attainment, age 25 and older by Zone, 2014-2018 average							
	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
Indicator	Rate	Count	Rate	Count	Rate	Count	Rate
Associate's degree or more	***28.1%***	6,100	***38.6%***	71,700	***51.4%***	222,800	68.7%

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

2. Birth Risk Factors

Key points:

- The mothers of infants born in airport communities were less likely to have had adequate prenatal care than were their counterparts in Balance of County.
- Births by women in airport communities were more likely to be premature or low birthweight compared to Balance of County.

Prenatal care: Starting prenatal care early in pregnancy and continuing with regular visits improves the chances of a healthy pregnancy and birth. This indicator measures the percentage of live births for which a) prenatal care started before the end of the fourth month and b) 80% or more of the recommended number of visits occurred (Table 6). The prevalence of early and adequate prenatal care was lowest in Zone A (63.9%), lower than the Balance of County rate of 75.0%. The percentages of women with early and adequate prenatal care in Zone B (68.8%) and Zone C (71.1%) were also lower compared to Balance of County. The percentage with early and adequate prenatal care declined with proximity to the airport.

Premature birth (singletons): A premature birth is a birth at less than 37 weeks gestation and is a leading cause of disability in infants and death of newborns. Prematurity also causes developmental delays, impairment of hearing and vision and chronic respiratory problems. Exposure to PM 2.5 (fine particulate matter), an airborne toxin associated with SeaTac Airport, increases the risk of premature birth.[2–4] As with low birthweight, we limited the findings to singleton births to eliminate multiple births as a factor in the comparison. The annual percentage of premature births was higher in Zones A (9.8%), B (9.4%), and C (8.2%) compared to Balance of County (6.6%).

Low birthweight (singletons): Low birthweight, a weight at birth of less than 2,500g or roughly 5.5 lb., increases the risk of infant mortality, respiratory disorders, and neurodevelopmental disabilities. We limited the findings to singleton births to eliminate multiple births as a factor in the comparison (elective fertility treatments can increase the chance of multiple births). Low birthweight was higher in airport communities, ranging from 5.5% (Zone C) to 6.1% (Zone B) compared to Balance of County (4.7%).

Table 6

Birth risk factors
by Zone, 2014-2018 average

Indicator	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
	Percent of live births	Count	Percent of live births	Count	Percent of live births	Count	Percent of live births
Early and adequate prenatal care[1]	***63.9%***	300	***68.8%***	2,367	***71.1%***	5,042	75.0%
Premature births (singleton)[2]	**9.8%**	48	**9.4%**	334	**8.2%**	593	6.6%
Low birthweight (singleton)[3]	**5.8%**	28	**6.1%**	217	**5.5%**	400	4.7%

[1] "Early and adequate prenatal care" based on Kotelchuck Index (>= 80% of expected prenatal care visits).

[2] A low birth weight is a weight at birth of less than 2500g.

[3] A premature birth is a birth at less than 37 weeks gestation.

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

3. Overall Health, Access to Care and Risk Factors in Children and Adults

Key points:

- Adults were more likely to be uninsured and/or not get needed medical care in airport communities than in Balance of County. A greater percentage of school-age children in Zones B and C did not have a dental checkup during the last year compared to those in Balance of County.
- Obesity was higher in airport communities for both children and adults than in Balance of County.
- Cigarette smoking and/or e-cigarette use or vaping among students in 8th, 10th and 12th grades in airport communities did not differ from that of students in Balance of County. Adults in Zones B and C were more likely to report smoking than were those in Balance of County.
- Lack of physical activity for adults was more prevalent in airport communities compared to Balance of County. School-age children in Zone B were less likely to meet physical activity guidelines as in Balance of County.
- Among adults, high blood pressure and inadequate sleep were both more common in Zones B and C than in Balance of County.

Children

Overall health status: A lower percentage of parents/primary caregivers rated their children's health as excellent or very good in Zones B (82.9%) and C (86.5%) compared to Balance of County (92.1%; Table 7). The percentage of parents/primary caregivers rating their children's health as excellent or very good in Zone A (88.4%) appeared higher compared to Balance of County.

Child did not receive needed health care: Parents/primary caregivers were more likely to report that their child had needed health care but not received it during the last year in Zone B (6.1%) than in Balance of County (2.9%). Data from the American Community Survey show that the proportion of children under 19 without medical health insurance was less than 2.5% in both airport communities and Balance of County (data not shown).

No dental checkup in the last year: Having an annual dental checkup represents preventive care. A greater percentage of 8th-, 10th-, and 12th-grade students in Zones B (19.2%) and C (16.9%) did not have a

dental checkup in the last year. compared to Balance of County (11.8%). Overall, the percentage of youth with no dental checkup in the last year increased as grade level increased (data not shown).

Cigarette smoking and e-cigarette or vape pen use: The percentage of 8th-, 10th-, and 12th-grade students who smoked in the last 30 days in Zones B and C (5.2% each) did not differ from Balance of County (4.4%).The percentage of students using e-cigarettes or vape pens during the last month in Zones B (11.3%) and C (12.8%) also did not differ from Balance of County (14.4%).

Overall, the percentage of 8th-, 10th-, and 12th-grade students smoking cigarettes one or more days out of the last 30 days increased as grade level increased (data not shown). E-cigarettes and vape pens are now the most common form of tobacco use among 8th-, 10th-, and 12th-grade students, and use increased with an increase in grade (data not shown).

Met physical activity recommendations: Being physically active helps control weight, strengthens bones and muscles, and boosts mental health and academic performance. The percentage of 8th-, 10th-, and 12th-grade students who met physical activity recommendations (being physically active for a total of at least 60 minutes for each of the last seven days) decreased as grade level increased (data not shown). Students in 8th-, 10th-, and 12th-grade in Zone B (18.2%) were less likely to report having met the recommendation than students in Balance of County (21.3%). The rate for Zone C students (19.6%) did not differ from that of Balance of County.

Obese: Obese children are more likely to have high blood pressure and cholesterol, type 2 diabetes, anxiety, and depression and to be targets of bullying. Youth are considered obese if their body mass index is in the top 5% for their age and gender. The prevalence of obesity in 8th-, 10th-, and 12th-grade students in Zones B (15.2%) and C (12.2%) was higher than the rate for Balance of County (7.5%).

Table 7

Children: Overall health status , access to care, and risk factors by Zone, various years (shown in footnotes)							
	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
Indicator	Rate	Count	Rate	Count	Rate	Count	Rate
Child overall health status excellent or very good (age 6 months through 5th grade)[1,2]	88.4%	N/A	***82.9%***	N/A	***86.5%***	N/A	92.1%
Child did not receive needed health care (age 6 months through 5th grade)[2]	6.1%*	N/A	**6.1%**	N/A	3.8%	N/A	2.9%
Dental checkup: None in last year (grades 8, 10, 12)[3]	^^	^^	**19.2%**	N/A	**16.9%**	N/A	11.8%
Current cigarette smoking (grades 8, 10, 12)[3,4]	^^	^^	5.2%	N/A	5.2%	N/A	4.4%
Current e-cigarette or vape pen use (grades 8, 10, 12)[3,5]	^^	^^	11.3%	N/A	12.8%	N/A	14.4%
Met physical activity recommendations (grades 8, 10, 12)[3,6]	^^	^^	***18.2%***	N/A	19.6%	N/A	21.3%
Obese (grades 8, 10, 12)[3,7]	^^	^^	**15.2%**	N/A	**12.2%**	N/A	7.5%

[1] Children whose caregivers reported their health status as excellent or very good.

[2] 2017, 2019 average

[3] 2016, 2018 average

[4] Smoked cigarettes on one or more days in the past 30 days.

[5] Used e-cigarettes or vape pens on one or more days in the past 30 days.

[6] Active for at least 60 minutes per day for the last 7 days.

[7] Body mass index was in the top 5% for age and gender.

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

*Rate is unstable; use with caution.

^^Data suppressed to meet confidentiality standard.

N/A: Estimated counts were not available for these measures.

Adults

Health status fair/poor: In Zone A, one in four (25.5%) of adults reported fair/poor health, compared to one in 10 (10.0%) adults in Balance of County (Table 8). The percentage of adults rating their health as fair or poor in Zones B (15.7%) and C (14.9%) was also higher.

Uninsured (non-elderly adults): Among adults 19 to 64 years of age, the percentage lacking insurance in Zones A (14.3%) and B (13.8%) was more than double that of Balance of County (5.8%). The rate in Zone C (8.9%) was also higher than in Balance of County.

Could not see doctor due to cost: Over one-quarter of adults in Zone A (26.3%) reported that they could not see a doctor when needed in the past year because of cost, more than double the rate in Balance of County (9.8%). The percentage of adults who reported not seeing a doctor due to cost in Zone B (14.1%) was also higher than in Balance of County.

Current smoker: A higher percentage of adults reported smoking in Zones B (17.7%) and C (12.1%) than in Balance of County (9.5%).

High blood pressure: The percentage of adults reporting high blood pressure in Zone B (29.3%) and Zone C (28.3%) was higher than the percentage in Balance of County (23.6%).

Obese: An obese adult has a body mass index (BMI) of 30 or higher. People who have obesity have a higher risk of death overall, high blood pressure, heart disease, diabetes, and many other serious physical and mental health conditions. Obesity among adults was more prevalent in Zones A (44.3%), B (29.2%), and C (24.4%) compared to Balance of County (19.1%).

No physical activity in leisure time: Physically inactive adults have a higher risk of cardiovascular disease, obesity, and type 2 diabetes, and generally incur higher medical costs. In Zone A, roughly one-third (31.7%) of adults reported being physically inactive (not participating in physical activity or exercise in the last month), which is 2.6 times higher than the Balance of County rate (12.1%). Physical inactivity rates in Zones B (20.5%) and C (17.5%) were also higher than Balance of County.

Inadequate sleep: Not getting enough sleep is associated with obesity, type 2 diabetes, and sleep apnea (a risk factor for hypertension, stroke, and other conditions) and can be caused by environmental noise.[5] A greater percentage of adults in Zones B (34.5%) and C (35.0%) reported inadequate amounts of sleep (less than seven hours per night) compared to Balance of County (27.0%). The prevalence of inadequate sleep in Zone A (33.5%) appeared higher than Balance of County but the difference was not statistically significant.

Parents/caregivers of children in elementary school or younger who reported inadequate sleep did not differ between airport communities and Balance of County. Results differ from the prior measure, and this is likely due to the difference in who was asked, as these results are from parents/caregivers of younger children and not adults of all ages.

Table 8

Adults: Overall health status, access to care and risk factors by Zone, various years (shown in footnotes)							
	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
Indicator	Rate	Count	Rate	Count	Rate	Count	Rate
Health status fair/poor[1]	**25.5%**	6,000	**15.7%**	31,500	**14.9%**	69,500	10.0%
Uninsured (age 19-64)[1]	**14.3%**	2,800	**13.8%**	23,200	**8.9%**	35,000	5.8%
Could not see doctor due to cost[1]	**26.3%**	6,100	**14.1%**	28,200	11.3%	53,000	9.8%
Current smoker (adult)[1]	8.2%*	1,900	**17.7%**	35,400	**12.1%**	56,700	9.5%
High blood pressure[1]	27.3%*	6,400	**29.3%**	58,500	**28.3%**	132,300	23.6%
Obese[1]	**44.3%**	10,300	**29.2%**	58,300	**24.4%**	113,900	19.1%
No physical activity in leisure time[1]	**31.7%**	7,400	**20.5%**	41,000	**17.5%**	81,600	12.1%
Inadequate sleep[2,3]	33.5%	7,800	**34.5%**	69,000	**35.0%**	163,700	27.0%
Children with a caregiver with inadequate sleep[2,4]	28.9%	NA	35.0%	NA	30.0%	NA	27.3%

[1] 2014-2018 average

[2] Inadequate sleep is sleeping less than 7 hours in a 24-hour period, on average.

[3] 2013, 2014, 2016 and 2018 average

[4] 2019 only

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

*Rate is unstable; use with caution.

NA: Estimated counts not available.

4. Chronic Conditions: Asthma, Stroke, Chronic Obstructive Pulmonary Disease, Heart Disease, Diabetes and Depression

Key points:

- The self-reported prevalence of chronic conditions among adults rarely differed between airport communities and the Balance of County, with two exceptions. Compared to Balance of County, a higher percentage of adults in Zone C reported ever having had a stroke, and a higher percentage of adults in Zones B and C reported having diabetes.
- Age-specific hospitalization rates for asthma in both children and adults were higher in Zones B and C than in Balance of County.
- Hospitalization rates for stroke, diabetes, and heart disease were higher in airport communities than in Balance of County. Heart disease rates were between 1.1 and 1.9 times higher and diabetes hospitalization rates were between 1.4 and 2.5 times higher. Hospitalization rates for heart disease increased the closer you are to the airport.
- Depression was relatively common for both school-age children and adults. About one in three school-age children in Zones B and C reported depression in the last year, a higher rate than in Balance of County.

Asthma: The rates of asthma hospitalization for both children and adults were higher in Zones B and C compared to Balance of County (Table 9). In Zones B and C and Balance of County, the risk of asthma hospitalization for children was much higher than risk among adults. In Zone B, for example, the rate among adults was 28.4 per 100,000 and among children it was 100.1 per 100,000.

Asthma prevalence estimates for adults in the airport communities did not differ from Balance of County. No recent, local estimates were available for asthma prevalence in children.

Stroke: The stroke hospitalization rate for people in airport communities was higher compared to the rate in Balance of County. The percentage of people who reported ever having had a stroke in airport communities appeared to be higher than in Balance of County, but only the difference between Zone C (3.1%) and Balance of County (1.9%) was significant.

Chronic obstructive pulmonary disease (COPD): Hospitalization for COPD was less common than for the other chronic conditions examined except asthma among adults. Though the rate of COPD hospitalizations in airport communities appeared higher than that of Balance of County, only the rate in Zone C (68.3 per 100,000) was significantly higher than the rate in Balance of County (52.3 per 100,000). Self-reported prevalence of COPD did not differ in airport communities from Balance of County.

Heart disease: Hospitalization rates for heart disease were higher than in the Balance of County, and rates were higher the closer you are to the airport. Zone A's hospitalization rate (876.5 per 100,000) was 1.9 times the rate for Balance of County (463.3 per 100,000). The rates for Zone B (600.4 per 100,000) and Zone C (520.4 per 100,000) were also higher than the rate in Balance of County. In Zones B and C, the percentage of people who self-reported ever having a heart attack appeared higher compared to Balance of County, though the difference was not statistically significant.

Diabetes: The hospitalization rates for diabetes in airport communities were higher than in Balance of County (between 1.4 and 2.5 times higher). The self-reported prevalence of adult diabetes was more common than other self-reported, physical chronic conditions examined except for depression, and the percentage of people who reported having diabetes in Zones B (9.9%) and C (8.2%) was higher than in Balance of County (6.3%). The percentage reporting having diabetes in Zone A did not differ from Balance of County.

Depression: Self-reported depression in school-age students was relatively scommon. About one in three students in grades 8, 10, and 12 in Zones B and C reported being feeling so depressed for two weeks or more in the last year that they did not do some usual activities (data not shown). Self-reported depression was significantly more prevalent in Zones B (34.4%) and C (33.5%) than in Balance of County (29.4%).

Self-reported history of being diagnosed with a depression-related disorder was also common in adults. About one in five adults in Zones B and C, and in Balance of County reported a history of depression. The prevalence did not significantly differ by zone.

Table 9

Chronic conditions: prevalence and hospitalization
by Zone, 2014-2018 average

Cause	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
	Rate[1]	Count	Rate[1]	Count	Rate[1]	Count	Rate[1]
Prevalence							
Has asthma now[2]	5.6%*	1,300	8.2%	16,400	10.0%	46,600	8.3%
Ever had stroke[2]	2.8%*	600	3.4%	6,900	**3.1%**	14,600	1.9%
Ever had heart attack[2]	2.7%*	600	3.6%	7,100	3.4%	16,000	2.5%
Chronic obstructive pulmonary disease[2,3]	2.9%*	700	4.8%	9,600	4.1%	19,300	3.3%
Diabetes[2]	11.8%*	2,800	**9.9%**	19,800	**8.2%**	38,200	6.3%
Depression (school-age)	^^	^^	**34.4%**	N/A	**33.5%**	N/A	29.4%
Depression (adults)[2]	11.3%*	2,600	20.5%	40,900	22.2%	103,600	21.5%
Hospitalization							
Asthma (adult)	^^	^^	**28.4**	^^	**28.5**	^^	16.6
Asthma (child)	^^	^^	**100.1**	^^	**86.8**	^^	71.3
Cerebrovascular diseases (stroke)[4]	**304.8**	17	**270.3**	413	**241.9**	981	213.0
COPD[3,4]	81.7	5	59.4	94	**68.3**	286	52.3
Diabetes[4]	**179.7**	10	**133.2**	202	**102.5**	414	70.6
Diseases of the heart[4]	**876.5**	48	**600.4**	918	**520.4**	2,134	463.3

[1] Prevalence rate is percent (rate/100); hospitalization rate is rate/100,000.

[2] Age 18 and older.

[3] COPD is chronic obstructive pulmonary disease.

[4] Rates are age-adjusted.

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

*Rate is unstable; use with caution.

^^Data suppressed to meet confidentiality standard.

N/A: counts not available.

5. Life Expectancy and Leading Causes of Death

Key points:

- The closer you are to the airport, the shorter the average life expectancy.
- People residing in airport communities had higher rates of death overall compared to the rate in Balance of County, and the rate increased the closer you are to the airport.
- Residents of airport communities had higher rates of death from heart disease, unintentional injury, chronic lower respiratory disease, diabetes, chronic liver disease, and homicide than did people in the Balance of County.
- The rate of death from heart disease was higher the closer you are to the airport.

- People living in Zones A and B had a higher rate of cancer compared to Balance of County. People living in Zone B also had a higher rate of lung cancer than those in Balance of County.
- Poisoning, largely due to drug and alcohol overdose, was the leading cause of unintentional injury death, and the death rate was 1.2 to 2 times higher in airport communities than in the rest of King County.

Life expectancy: Life expectancy in airport communities was lower than that of Balance of County and decreased the closer you are was to the airport (Table 10). The life expectancy of people in Zone A, closest to the airport, was 5.0 years lower than that of people living in Balance of County.

Table 10

Life expectancy at birth
by Zone, 2014-2018 average

Indicator	Zone A: <1 mile from airport	Zone B: 1 to <5 miles from airport	Zone C: 5 to 10 miles from airport	Balance of County
	Years	Years	Years	Years
Life expectancy	***77.9***	***79.4***	***81.2***	82.9

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

Leading causes of death: People residing in airport communities had higher rates of death across all causes than in Balance of County and the rate increased the closer you are to the airport (Table 11). Residents of airport communities had higher rates of death from heart disease, unintentional injury (accidents), chronic lower respiratory disease, diabetes, chronic liver disease, and homicide than did people in Balance of County. People living in Zones A and B had a higher death rate from cancer and those in Zones B and C had a higher rate from stroke compared to the rate in the Balance of County. The heart disease death rate was higher the closer you are to the airport.

Alzheimer's disease is the only leading cause of death that was lower in an airport community (Zone B) compared to Balance of County. The rate of suicide deaths in airport communities did not differ from the rate in Balance of County.

Table 11

Leading causes of death[1] by Zone, 2014-2018 average							
	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
Cause Of Death	Rate[2]	Count	Rate[2]	Count	Rate[2]	Count	Rate[2]
All causes	**808.6**	248	**723.4**	1,901	**639.1**	3,950	572.2
Cancer	**158.7**	48	**160.9**	428	138.6	878	135.3
Diseases of heart	**187.7**	59	**142.9**	374	**126.6**	783	115.3
Alzheimer's disease	52.2	17	***38.1***	96	43.7	259	47.8
Accidents (Unintentional injuries)	**45.8**	14	**39.1**	106	**35.7**	222	30.4
Cerebrovascular diseases (stroke)	32.7	11	**34.9**	90	**34.5**	209	28.8
Chronic lower respiratory diseases	**38.5**	10	**34.9**	90	**27.6**	168	22.5
Diabetes mellitus	**33.9**	10	**26.3**	70	**22.0**	137	14.4
Intentional self-harm (suicide)	9.8	3	13.1	35	11.8	75	11.8
Chronic liver disease and cirrhosis	**18.8**	6	**13.1**	37	**10.2**	69	7.9
Influenza and pneumonia	14.3	4	**13.5**	35	10.0	61	8.6
Essential hypertension and hypertensive renal disease	10.9	4	**10.6**	28	**9.1**	55	6.8
Nephritis[3]	^^	^^	**8.6**	22	**6.6**	41	4.6
Septicemia	7.0*	2	**9.1**	24	**7.0**	42	4.1
Assault (homicide)	**6.6***	2	**7.9**	20	**4.0**	24	1.1
Certain conditions originating in the perinatal period	^^	^^	**4.0**	11	**3.2**	17	1.8

[1] The list of leading causes was developed by including any cause of death that is one of the 10 leading causes in any race group.

[2] Rates are age-adjusted rates per 100,000 population.

[3] Nephritis, nephrotic syndrome and nephrosis

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

*Rate is unstable; use with caution.

^^Data suppressed to protect confidentiality.

Cancer deaths: Though rates of cancer deaths overall were higher among people living in Zones A and B compared to Balance of County, rates for leading causes of cancer deaths did not show the same pattern (Table 12). Residents of Zone B had a higher rate of death from lung cancer and colorectal cancer compared to the Balance of County.

Table 12

Leading causes of cancer death[1]
by Zone, 2014-2018 average

Cause Of Death	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
	Rate[2]	Count	Rate[2]	Count	Rate[2]	Count	Rate[2]
Lung cancer[3]	36.1	11	**36.5**	96	29.9	188	27.7
Colorectal cancer	10.8	3	**14.8**	40	11.0	70	11.2
Breast cancer (female)	20.5	3	20.0	28	19.4	68	18.1

[1] Leading causes of cancer death were ranked by number of deaths in King County. The leading 3 were chosen.

[2] Rates are age-adjusted rates per 100,000 population.

[3] Cancer of the trachea, bronchus and lung

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

Unintentional injury deaths: Poisoning, falls, and traffic crashes were the most common causes of unintentional injury deaths. Nationally and locally, the majority of poisoning deaths are from drug abuse. The annual report from the King County Medical Examiner's office on drug and alcohol overdose deaths shows a substantial increase from 2014 to 2018, the time period that forms the dataset of deaths for our report.[ii] Rates of death by poisoning were higher in airport communities compared to Balance of County and were higher the closer you are to the airport (Table 13). The rate of traffic deaths was higher in Zone B than in Balance of County.

Table 13

Leading causes of unintentional injury death[1]
by Zone, 2014-2018 average

Injury Mechanism	Zone A: <1 mile from airport		Zone B: 1 to <5 miles from airport		Zone C: 5 to 10 miles from airport		Balance of County
	Rate[2]	Count	Rate[2]	Count	Rate[2]	Count	Rate[2]
Poisoning	**20.1**	6	**14.8**	41	**12.4**	80	10.2
Falls	8.4	3	10.4	27	11.1	68	11.1
Motor Vehicle-Traffic	8.4	3	**7.1**	19	5.5	34	4.2

[1] Leading unintentional injury mechanisms were ranked by number of deaths in King County. The leading 3 were chosen.

[2] Rates are age-adjusted rates per 100,000 population.

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

[ii] For more information, see https://www.kingcounty.gov/depts/health/~/media/depts/health/medical-examiner/documents/2018-overdose-death-report.ashx.

6. Excess Deaths: How Many Fewer Deaths Would Occur if the Airport Communities Had the Same Risk of Death as the Balance of King County?

Key points:

- Across four of the leading causes of death in the county (heart disease, cancer, accidents, and stroke), the number of deaths in airport communities exceeded the expected number of deaths if airport communities had the same death rates as the Balance of County. Observed deaths from these causes ranged from 1.1 to 2.3 times higher than expected in the airport communities.
- Across the airport communities, deaths from cancer were between 1.1 and 1.4 times higher than expected, heart disease deaths were between 1.3 and 2.3 times higher, unintentional injury deaths were between 1.2 and 1.8 times higher, and stroke deaths were between 1.4 and 1.9 times higher than expected.

We estimated the number of excess deaths in airport communities by calculating the number of deaths that would occur if the population of airport communities was dying at the same rate as in Balance of County (see Appendix A for details). We included the five leading causes of death in King County: cancer, heart disease, Alzheimer's disease, unintentional injuries, and stroke. Many of the excess deaths may be preventable, given the elevated prevalence of physical inactivity, obesity, smoking, high blood pressure and potential exposure to airport-related pollution in some or all of the airport communities.

The number of excess deaths is the observed (actual) deaths minus the number of expected deaths. We also calculated the mortality ratio: the number of observed deaths divided by the expected deaths. A mortality ratio of greater than one means the number of observed deaths was higher than expected, and a ratio of less than one means observed deaths were less than expected.

Zone C, the airport community with the largest population, had the highest number of excess deaths (Table 14). Zone B had fewer estimated excess deaths and Zone A, with the smallest population size, had the lowest number of excess deaths.

In four out of the five leading causes, the number of deaths in airport communities exceeded the expected number of deaths. Cancer deaths were between 1.1 and 1.4 times higher than expected across the airport communities. Death from heart disease were 2.3 times higher in Zone A, 1.6 times higher in Zone B, and 1.3 times higher in Zone C. Unintentional injury deaths were between 1.2 and 1.8 times higher than expected. Stroke deaths were between 1.4 and 1.9 times higher than expected. Alzheimer's disease was the only cause of death for which observed deaths were not different from expected deaths.

Table 14

Excess deaths in airport communities[1]

5 leading causes of King County deaths, 2014-2018 average

Cause Of Death	Observed per year[2]	Expected per year[3]	Excess per year[4]	Mortality ratio[5]
Zone A: Less than 1 mile from airport				
Cancer	35	25	10	**1.4**
Diseases of heart	28	12	16	**2.3**
Alzheimer's disease	2	1	0	1.3
Accidents (Unintentional injuries)	12	7	5	**1.8**
Cerebrovascular diseases (stroke)	5	2	2	**1.9**
Zone B: 1 to less than 5 miles from airport				
Cancer	299	234	65	**1.3**
Diseases of heart	181	113	69	**1.6**
Alzheimer's disease	11	13	0	0.8
Accidents (Unintentional injuries)	82	58	24	**1.4**
Cerebrovascular diseases (stroke)	40	22	18	**1.8**
Zone C: 5 to 10 miles from airport				
Cancer	600	569	31	**1.1**
Diseases of heart	359	275	85	**1.3**
Alzheimer's disease	32	32	0	1.0
Accidents (Unintentional injuries)	170	138	32	**1.2**
Cerebrovascular diseases (stroke)	76	54	22	**1.4**

[1] Calculations exclude age 80 and older. See Appendix A for details.

[2] Observed per year is the number of actual deaths.

[3] Expected per year is the number of deaths that would have occured if the death rate was the same as the death rate in Balance of County. See Appendix A for details.

[4] Excess per year is the number of observed deaths minus the number of expected deaths. Numbers may not total due to rounding.

[5] Mortality ratio is the Zone's death rate divided by the death rate in Balance of County. See Appendix A for details.

Higher than Balance of County
Lower than Balance of County
Not different from Balance of County

7. Glioblastoma Cancer Incidence

Key points:

- During 2013-2017 combined, 400 new cases of glioblastoma were diagnosed in King County.
- The age-adjusted incidence rates of glioblastoma cancer for the airport communities did not differ from that of Balance of County.

Washington State Department of Health staff examined the incidence of glioblastoma cancer in King County by zone and found no differences in age-adjusted incidence rates. During 2013-2017 combined, 400 new cases of glioblastoma were diagnosed in King County. The age-adjusted incidence rate for Zone A was suppressed due to the low number of new cases but did not differ from that of Balance of County. The rates for Zone B and C also did not differ from Balance of County.

Table 15

Glioblastoma incidence
By zone, 2013 – 2017

Measure	Zone A	Zone B	Zone C	Balance of County	King County Overall
Age-adjusted incidence rate	^^	2.8	3.5	3.9	3.7
Confidence Interval for rate	^^	2.0 – 3.9	2.8 – 4.2	3.4 – 4.5	3.3 – 4.0
Average new cases per year	^^	8	23	48	80
Average population per year	^^	256,761	594,870	1,180,605	2,062,150

^^ Counts, rates and confidence intervals were not calculated if there are fewer than 10 new cases for the combined data from 2013-2017.

Note: Rates are per 100,000 and age-adjusted to the 2000 US Std Population (19 age groups) standard; rate confidence intervals are 95%. Invasive glioblastoma cancer is coded using International Classification of diseases for Oncology Third Edition (ICD-O-3) histology codes 9440-9442 with behavior code 3 (malignant); the airport communities and Balance of County areas were created using the 2010 census tracts.

Data Sources: Washington State Cancer Incidence data were from the Washington State Department of Health, Washington State Cancer Registry, released in March 2020. Population estimates were from the Washington State Office of Financial Management, released in January 2020.

III. WHAT POLLUTANTS RESULT FROM AIRPORT OPERATIONS AND WHAT ARE THE LIKELY HEALTH IMPACTS?

Report Requirement 2: Comprehensive literature review

> Proviso language: A comprehensive literature review concerning the community health effects of airport operations, including a strength-of-evidence analysis

A. SUMMARY

Airport operations result in noise and air pollution, which likely affect population health at common concentration levels. Noise pollution contributes to hypertension and heart disease and likely causes poor school performance among children. Air pollution impacts numerous organ systems (Table 16), and effects are especially pronounced for cardiovascular and respiratory outcomes. The air pollutants related to airport operations include particulate matter of various sizes, ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur oxides (SO_x), and other hazardous air pollutants. Fine particulate matter ($PM_{2.5}$) causes cardiovascular and respiratory problems, and likely causes cancer and central nervous system conditions, including dementia and neurodegeneration.

Existing research is less conclusive about larger and smaller particulate matter in comparison, though recent research demonstrates that exposure to both increases the risk of preterm births and respiratory concerns, among other issues. Ozone, NO_2, and SO_x cause short-term respiratory issues. NO_2 likely causes long-term cardiovascular problems, and CO causes short-term cardiovascular concerns and likely affects lung functioning. These pollutants are especially concerning for people with underlying respiratory or cardiovascular issues because they worsen existing conditions, though long-term exposures increase risk in the general population for developing problems. The hazardous air pollutants (HAPs) found at airports are known or suspected carcinogens and/or cause birth defects. Lead exposures are more common at Boeing Field, Renton, and Auburn airports than at SeaTac airport, because small planes with piston engines still use leaded gasoline. Lead causes central nervous system problems and is damaging even at low levels, thus is worth mentioning despite less prevalence at SeaTac airport.

Table 16

Health outcomes likely caused or caused by airport operations–related pollutants based on evidence to date		
Organ System	**Noise Pollution**	**Air Pollutants**
Cardiovascular	Causal	Causal
Respiratory	Not examined	Causal
Reproductive & fertility	Not examined	Causal
Birth outcomes	No causal evidence	Likely causal
Cancer	Not examined	Causal
Central nervous system	No causal evidence	Causal
Metabolic system	No causal evidence	No causal evidence

The type of exposure, amount of exposure, and length of exposure to pollutants can all impact risk. Vulnerable populations such as those with underlying heart conditions, heart disease, and asthma are more likely be affected by lower concentrations of air pollution and noise and more seriously affected

by higher levels of pollutants. Children and people with underlying health conditions such as asthma, other respiratory issues, and heart conditions are more vulnerable to pollutants. Risk of pollutant exposure is also related to socioeconomic status (SES); both individual SES and average SES of neighborhood independently impact health. People of color and people of lower SES face much higher health risks from air pollution and noise pollution compared to Hispanic/Latino populations and people of higher SES.[6] People of color and people of lower SES are also more likely to be exposed to higher levels of air pollution and noise pollution.

Multiple studies in the U.S. and other countries demonstrate higher noise levels related to airport operations and specifically aircraft.[7–9] Locally, a community-driven study of aviation noise demonstrated frequent noise pollution over FAA standards and well over World Health Organization (WHO) standards for environmental noise. Similarly, higher levels of air pollutants compared to ambient levels were found at several airports. Researchers with the University of Washington's Environmental and Occupational Health Sciences Department conducted the first study of UFP concentrations near the SeaTac airport during 2018–19 and found higher concentrations of ultra UFP (10–20 nanometers) below aircraft flight paths, with the highest concentrations associated with landings compared to departures. They concluded that communities underneath and downwind of the flight path are exposed to aircraft-related UFP concentrations.

B. LITERATURE REVIEW AND STRENGTH-OF-EVIDENCE ANALYSIS METHODS

This review of the literature examined the strength-of-evidence of research regarding airport-related air and noise pollution and the likelihood of harm to human health resulting from exposures. We reviewed the Environmental Protection Agency's most recent Integrated Science Assessment (ISA) per pollutant, because these documents represent consensus among EPA specialists and external subject matter experts. We also considered peer-reviewed literature and technical reports primarily published after the most recent ISA. Analysis is based on a review of 33 reports, including the ISAs; two letters by scientists involved in ISA production; and over 500 journal articles.

The strength-of-evidence analysis assessed the association between exposure and outcomes based on all relevant studies, given the quality of those studies. In other words, we drew conclusions about how strong the evidence to date was that various health outcomes are caused by air and noise pollution related to airport operations. Whenever possible, determinations draw directly on causality assessments in ISAs, technical reports, and systematic reviews, because they represent causal assessments made by subject matter experts. When ISAs were not available or older, such as for ultrafine particles and noise pollution, determinations relied more on systematic reviews and technical reports.

The strength-of-evidence criteria used for this analysis are based on the five-level causal framework that the EPA uses to assess air pollutant effects on health when conducting an ISA (Table 17).[10] A relationship is considered causal when multiple, high quality studies conducted by multiple researchers shows that exposure leads to the health outcome in question, the biological pathways of harm are supported by the evidence available, and alternative explanations have been ruled out. A relationship is considered likely causal when multiple, high-quality studies support that exposure leads to the effect, biological pathways are plausible but may be lacking some supporting evidence, and/or potential co-pollutant exposures have not yet been ruled out.

Table 17

Strength-of-Evidence Criteria Applied	
Causal	• Exposure is shown to lead to effect across multiple high-quality studies by multiple research groups. • Plausible alternative explanations for effect have been ruled out. • Biological pathways supported by evidence.
Likely Causal	• Exposure is shown to lead to effect across multiple high-quality studies, but uncertainties remain. • Plausible alternative explanations for effect have been ruled out but concerns about possible co-pollutant exposures may remain. • Biological pathways, while plausible, may be missing evidence.
Suggestive	• Exposure seems to lead to effect in at least one high-quality study, but alternative explanations for the effect, such as a third factor, cannot yet be ruled out. • May have a limited number of studies with modest effects or may have several studies with conflicting results.
Inadequate Evidence	It is unclear if exposure leads to effect or not, because of a lack of quality studies or because of significant inconsistency in results across studies.
Not Likely Causal	Exposure consistently does not appear to lead to effect across studies; adequate studies show no effect across different exposure levels and different populations.

The following review of the literature focuses on health impacts that are likely caused or caused by pollutants. Most information presented is from the ISAs; citations provide alternative and/or supplemental sources. Appendix C provides more details per pollutant, including health effects examined with findings suggestive of a relationship to the pollutant. Appendix D provides a visual description of health effects and pathways of harm for noise pollution, along with the five most common air pollutants associated with commercial airports.

C. LITERATURE REVIEW AND STRENGTH-OF-EVIDENCE ANALYSIS FINDINGS

The Seattle-Tacoma International Airport is the largest airport in Washington and in 2019 transported 51.8 million passengers and tons of cargo.[11] In 2018, the airport averaged 23 flights per hour per day, and from 6 a.m. through midnight typically experienced over 20 flights per hour.[12] Flights depart into the wind and land with the wind; at this airport, flights arrive and depart in a north-and-south pattern.[iii] For roughly 65% of the year, in the cooler months, winds come from the south; thus flights depart to the south and arrive from the north. Winds come from the north in the remaining months, so flights depart north and arrive from the south.

The airport's operations contribute to environmental pollution, with air and noise pollution having the largest impacts on community health. Most airport emissions come from airplanes, specifically the contrails formed from burning jet fuel. Planes idling or taxiing on runways increase emissions. Additional emissions result from vehicle traffic that are part of airport operations, some stationary sources within airports, and vehicle traffic going to and from the airport. The ground traffic pollutant with the greatest

[iii] For more information see https://www.portseattle.org/projects/flight-patterns.

impact is higher levels of black carbon within 500 meters of the source, though traffic-related air pollution can remain at elevated levels 1,500 feet from major roadways following rush hour.[13]

When planes taxi, take off, and land, air pollutants are blown downwind of the airplane in the contrails formed by engine exhaust. When planes are lower than 3,000 feet in the air, air pollutants travel downwind. When planes fly at cruising altitude above 3,000 feet, wind currents can carry pollution as far as 6,000 miles from the route. Pollution at these levels contributes to greenhouse gases, thus have a cumulative rather than direct impact on human health. Noise pollution, also called environmental noise, refers to elevated levels of unwanted sound in the environment that are disruptive or harmful for health and occur primarily as planes take off and land, though can also result from ground transportation.

This report focuses on airport-related impacts of noise and air pollution on communities, thus excludes occupational exposure to pollutants as well as water and soil pollution resulting from airport operations. Airport activities such as de-icing, washing, fuel spills, and other runoffs lead to water and soil pollution, which increases risks to ecosystems and impacts human health downstream when left untreated.[14] The review excludes the occupational health impacts of working at an airport, as well, to focus on airport operations–related impacts on general population health.

1. Noise Pollution Health Effects

Noise pollution refers to regular noise levels in the environment that are above levels identified as safe for human health. Road traffic noise and aircraft activity are the main sources of noise pollution related to airports. Aircraft noise is affected by the type of aircraft and engine, including its thrust, as well as environmental conditions influencing how sound travels, such as distance and weather.

Noise pollution impacts health by disrupting sleep and concentration and/or triggering stress and annoyance. Studies of self-reported sleep disruption and use of sedative medications confirm that noise pollution disrupts sleep.[15] Noise pollution activates the stress response in the body on a frequent basis, leading to chronic stress.[16] This can wear down various organ systems in the body, causing damage that can at a point become irreversible, which then increases risk for chronic diseases and early death.[17] Noise pollution can also disrupt sleep, which limits the body's recovery from stress. The body's stress response to noise can be, but does not have to be, triggered by conscious annoyance with noise levels. A stress response is also triggered automatically, even if noise levels are not consciously registered as annoying.[5] Chronic stress contributes to circulatory and cardiovascular health concerns. Very high levels of noise pollution can induce hearing loss, and non-auditory health impacts of noise pollution exposure include hypertension, cardiovascular problems, and reduced cognitive functioning (Table 18; see Figure D1 in Appendix D for pathways of harm).

School performance and cognition: Multiple studies found an association between children in schools exposed to higher noise pollution levels and poorer standardized test performance, reading comprehension and memory. Some of these controlled for other factors, including levels of air pollution, though many were cross-sectional.[8,18] A prospective longitudinal study conducted in Munich showed that students' poor short-term memory and reading cognition disappeared two years after the nearby airport was closed.[19] The mechanisms by which noise pollution affects cognition are not well identified. It could be that children are exposed to noise pollution at home, which impacts sleep and stress, and/or noise from aircrafts and other sources is chronically disruptive to classroom activity in schools highly exposed to noise pollution.[8,20]

Table 18

Health outcomes resulting from noise pollution *based on evidence to date*	
Health outcome	**Noise Pollution Impact**
Cardiovascular	Causal
Sleep disturbance	Causal
Annoyance	Causal
School performance	Likely causal

Cardiovascular problems: Long-term noise pollution can lead to chronic stress, inflammation, and oxidative stress, which in turn can lead to increased risk of hypertension[21,22] and heart disease.[23–26] These exposures also increase risk of stroke,[27] heart attack,[28] heart-related hospitalizations, and cardiovascular-related death.[29] The evidence is particularly strong that noise pollution contributes to ischemic heart disease.[23,24] The adverse health effect of noise pollution from aircraft has been validated locally. A retrospective cohort study confirmed that in Seattle, as in 88 other airport communities, airport-related noise exposure significantly increased the likelihood of hospital admissions for cardiovascular issues among people 65 years of age and older.[9]

Researchers have observed higher rates of diabetes and other metabolic outcomes in communities exposed to higher noise pollution, controlling for other factors,[21,30,31] though evidence is limited to a small number of studies. Other studies examined the presence of noise pollution and adult anxiety and depression symptoms and cognitive scores, but air pollution was not always controlled for and results were inconsistent.[8,32,33]

2. Air Pollution Health Effects

Air pollution from airport operations includes a variety of pollutants with varying quantities of emissions. The air pollutants of most concern related to aircraft and road traffic activity are:[34]

- Particulate matter (PM) classified by size as coarse PM, $PM_{2.5}$, and ultrafine PM (UFP);
- carbon monoxide (CO);
- nitrogen dioxide (NO_2);
- sulfur oxides (SO_x);
- ozone (O_3);
- lead (Pb); and
- some hazardous air pollutants (HAPs), also known as volatile organic compounds (VOCs).

The first six are criteria air pollutants, known to cause harm to human health and the environment and monitored and regulated by the Environmental Protection Agency (EPA) under the Clean Air Act, with the exception of UFP. Hazardous air pollutants are known or suspected to cause cancer or birth defects, though they tend to be less prevalent than most criteria pollutants. Following is a brief description of pollutant sources and evidence of harm to human health.

Although all air pollutants released by airport activity have the potential to cause harmful health effects at commonly observed concentrations, PM is a common pollutant that can have wide-ranging, serious health effects (Tables 18–19). Many argue that particulate matter is the greatest threat to human health among common air pollutants.[35,36] Particulate matter (PM) from combustion sources is a mixture of tiny solid and liquid particles, most less than 1 micrometer (μm) in diameter. They contain varying amounts of nitrogen oxides, elemental carbon, and many different hydrocarbons and more complex substances—including formaldehyde, acrolein, polycyclic aromatic hydrocarbons, and similar chemicals, as well as a variety of metals. Particle size influences how the particles move through the air; smaller particles can remain in the air longer and travel farther. Particle size also influences how particles move through the human body. Smaller particles are also more likely to remain in the lungs and move to the bloodstream, while the body more easily expels larger particles before they get to the lungs. Particulate matter emissions related to airports come primarily from aircraft exhaust and road vehicles but also from ground support vehicles and equipment. The PM resulting from ground operations is mostly black carbon (or soot).[37] PM from aircraft emissions is largely carbon-based UFP.[38]

Coarse particulate matter (diameters between 2.5 and 10 μm) related to airport activity is generally emitted by road traffic, ground support equipment, aircraft landing and takeoff, and wear on aircraft brakes and tires during landing. Auxiliary power units, construction, and application of solvents can also

contribute to coarse PM at airports. Because of its larger size, coarse PM is less buoyant and settles out of the air quicker than smaller particles do, thus it tends not to drift as far as smaller PM.

When inhaled, larger coarse PM generally settles in the upper respiratory tract (nose to bronchi), though some gets further and deposits in the lungs (See Figure D2 in Appendix D for an illustration of pathways). Short-term coarse PM exposure may lead to respiratory problems.[39] Days of higher coarse PM exposure are associated with more asthma attacks. Evidence is mixed for exacerbation of COPD symptoms, though coarse PM exposures may increase susceptibility to respiratory infections, and people with underlying respiratory illness may be more likely to experience respiratory death on days following high coarse PM levels. Short-term and long-term coarse PM exposure may also lead to cardiovascular problems.[76,80] Days of exposure to higher coarse PM levels may lead to small increases in blood pressure. People with underlying cardiovascular disease may experience worsened symptoms, changes in heartbeat, and increased risk of blood clots or heart attack and higher risk of cardiac-related death in the days following higher coarse PM exposure. Exposure over several years may lead to higher rates of heart disease, stroke, and pulmonary embolism.[40]

Fine Particulate Matter (diameters less than 2.5 µm)*:* Short- and long-term $PM_{2.5}$ exposures cause cardiovascular, respiratory, and cerebrovascular problems (Table 19 and Figure D3 in Appendix D). People with heart disease or hypertension are at higher risk of heart attack, stroke, and cardiac-related death following days of higher $PM_{2.5}$ levels.[41] People without underlying heart disease can experience increases in blood pressure and heart rate variability following days of higher $PM_{2.5}$ levels. Populations exposed to even moderate levels of $PM_{2.5}$ over many years develop higher rates of heart disease and hypertension. These populations experience more heart attacks, strokes, and cardiac-related deaths. Though the 2009 ISA and the 2019 ISA draft conclude that $PM_{2.5}$ *likely causes* respiratory effects, many experts have concluded the evidence is strong that both short- and long-term exposures *cause* respiratory effects.[42,43] During days of higher $PM_{2.5}$ levels, people with asthma are at higher risk of asthma attack. People with COPD and people with allergies are likely to experience worsened symptoms. People with underlying respiratory illness are more likely to experience respiratory death. Populations without underlying respiratory conditions are at increased risk of contracting respiratory infections on days following higher $PM_{2.5}$ levels. Young children exposed to moderate $PM_{2.5}$ over several years are more likely to develop asthma.[44] Their lungs may also not develop fully.[45] Populations exposed to moderate $PM_{2.5}$ over several years experience more respiratory infections and have higher rates of respiratory-related death.

Table 19

Health outcomes resulting from Fine Particulate Matter based on evidence to date		
Health outcome	**Short-term Exposure Impact**	**Long-term Exposure Impact**
Cardiovascular	Causal	Causal
Respiratory	Causal	Causal
Nervous System	Suggestive evidence	Likely causal
Birth outcomes	Suggestive evidence	Likely causal

Long-term $PM_{2.5}$ exposure likely results in cancer and cancer-related deaths[46,47] as well as nervous system problems. Populations exposed to moderate $PM_{2.5}$ over several years have higher rates of lung cancer and lung cancer–related deaths. These populations aren't at higher risk of other types of cancer, but they are less likely to survive other types of cancer. Populations exposed to higher levels of $PM_{2.5}$ over several years have higher rates of dementia and cognitive decline among older adults.

Evidence is growing that $PM_{2.5}$ exposure increases risk of pre-term births. Researchers in Finland recently published findings from a population cohort study that controlled for pollutant exposures at home and relevant maternal characteristics like smoking.[3] They found that exposure to ambient NO, CO, SO_2, PM_{10}, and $PM_{2.5}$ during the third trimester increased risk of preterm birth; and exposure during week before pregnancy to $PM_{2.5}$ and PM_{10} and NO_2 increased risk of preterm birth. The short-term

exposure during the week before birth was associated with a 60–67% increase in the risk of preterm birth.[3]

Table 20

Health outcomes resulting from Ultrafine Pasrticulate Matter based on evidence to date		
Health outcome	**Short-term Exposure Impact**	**Long-term Exposure Impact**
Cardiovascular	Suggestive evidence	Inadequate to date
Respiratory	Suggestive evidence	Inadequate to date
Nervous system	Suggestive evidence	Likely causal
Birth outcomes	Suggestive evidence	Suggestive evidence

Ultrafine particulate matter (UFP; diameters less than 0.1 µm) was difficult to measure in the past and is not regulated, thus infrequently monitored. As a result, scientific understanding of the health effects of UFP is in early stages but quickly evolving (See Figure D4 in Appendix D for an illustration of pathways of harm). UFP levels are not yet regulated by the EPA, so UFP emissions data is scarcely collected. Because $PM_{2.5}$, which includes UFP, dominates the health risks associated with aircraft-related air pollution and UFP's small size allows it to penetrate even deeper into the body, experts anticipate that UFP is particularly important for health. Long-term UFP exposure likely causes nervous system problems (Table 20). Longer periods of exposure to high UFP concentrations likely lead to stress response and inflammation throughout the brain. People exposed to high UFP levels for long periods can experience neurodegeneration and potentially develop Alzheimer's. Long-term exposure to high UFP may impact cognitive abilities and lead to more impulsive behavior. Some evidence suggests UFP may lead to respiratory, cardiovascular, and central nervous system problems, given that short-term exposures can trigger inflammation in the lungs and brain as well as a stress response.

Researchers in the United States examined effects of UFP exposure for a birth cohort that resided within 10 miles of the Los Angeles airport.[48] After controlling for maternal characteristics, exposure to traffic related pollution, and airport-related noise, results showed that exposure to aircraft-related UFPs was associated with preterm births and the odds of preterm births increased with greater exposure levels.[48]

Ozone (O_3) is a gas that forms from nitrous oxides and HAP reactions in the air, rather than being directly emitted from the airport. Ozone concentrations near airports tend to be lower than levels in surrounding urban areas.[36] The nitrogen dioxide emissions near airports react with ozone in the air, keeping ozone concentrations low. While ozone exposure is less of a concern close to airports, airport activities still contribute to higher regional ozone levels by emitting VOCs (volatile organic compounds) and NO_x.[36] VOCs are a subgroup that includes all HAPs of concern near airports. Aircraft emissions contribute, however, to global pollution by increasing regional ozone concentrations, thus impacting human health on a regional scale.

Table 21

Health outcomes resulting from Ozone based on evidence to date		
Health outcome	**Short-term Exposure Impact**	**Long-term Exposure Impact**
Cardiovascular	Suggestive evidence	Suggestive evidence
Respiratory	Causal	Likely causal
Metabolic	Likely causal	Likely causal
Reproductive system	Suggestive evidence	Suggestive evidence

Ozone contributes to inflammation and oxidative stress (See Figure D5 in Appendix D). Short- and long-term exposure to ozone causes respiratory problems (Table 21). In the short-term, ozone can decrease lung functioning in young, healthy adults, which increases susceptibility to respiratory symptoms and infections and respiratory symptoms in general population. People with underlying respiratory issues are likely to suffer worse asthma, COPD, and allergies, leading to increased hospitalizations and greater risk of death. Long-term ozone exposure likely leads to development of asthma in children; increases susceptibility to respiratory infection, severe asthma, and development of allergies; and may lead to development of COPD. Some evidence suggests that short- and long-term ozone exposure may lead to cardiovascular effects, metabolic problems, and negative effect on cognition. Some findings show that ozone exposure

leads to impaired heart function, heart rate variability, inflammation or oxidative stress, and diabetes-related deaths, but results across all relevant studies are inconsistent. Some evidence shows an association with long-term exposure and blood pressure, hypertension, and cardiovascular mortality. Ozone exposures in first and second trimesters may lead to lower birth weight and pre-term birth, but alternative explanations have not been ruled out.

CO, NO_2, and SO_x can impact respiratory health in areas very close to emission sources, though airport activity emissions don't usually push regional concentrations above EPA standards. CO and NO_2 are released from the engines of planes, ground support vehicles and equipment, and road traffic.

Carbon monoxide (CO) causes inflammation and oxidative stress (Table 22; Figure D6 in Appendix D). The gas can also impact health by displacing oxygen in the bloodstream, which prevents organ systems in the body from receiving enough oxygen. Short-term CO exposure likely causes cardiovascular problems, specifically changes in heart rate due to lower oxygen in the blood. For people with underlying heart disease, exposures can worsen symptoms and trigger irregular heartbeat, which will increase risk of cardiac-related death.

Table 22

Health outcomes resulting from Carbon Monoxide based on evidence to date		
Health outcome	**Short-term Exposure Impact**	**Long-term Exposure Impact**
Cardiovascular	Likely causal	Likely causal
Respiratory	Suggestive evidence	Inadequate evidence
Nervous system	Suggestive evidence	Suggestive evidence
Reproductive system	Suggestive evidence	Suggestive evidence

Nitrogen Dioxide (NO_2) causes inflammation and oxidative stress, primarily in the respiratory tract and lungs (Table 23; Figure D7 in Appendix D). Short-term NO_2 exposure causes respiratory problems by worsening asthma symptoms and triggering asthma attacks. Exposure may also contribute to respiratory symptoms and susceptibility to respiratory infections in the general population. Exposure may worsen symptoms for those with allergies or COPD. Exposure may increase risk for respiratory-related death for those with underlying respiratory conditions. Long-term NO_2 exposure likely increases risk of developing asthma. Some evidence suggests that short- and long-term NO_2 exposure may worsen underlying heart disease, increasing risk of heart attacks and cardiac-related death. Longer-term exposures may contribute to development of heart disease. Long-term NO_2 exposure may increase risk of lung cancer, as well as increased risk of developing insulin resistance and type 2 diabetes. Exposure during pregnancy may be associated with autism spectrum disorder. Longer term exposures may be associated with dementia, Parkinson's disease, and cognitive decline.

Table 23

Health outcomes resulting from Nitrogen Dioxide based on evidence to date		
Health outcome	**Short-term Exposure Impact**	**Long-term Exposure Impact**
Cardiovascular	Suggestive evidence	Suggestive evidence
Respiratory	Causal	Likely causal
Nervous system	Inadequate evidence	Suggestive evidence
Reproductive system	Suggestive evidence	Inadequate evidence

Sulfur oxides cause inflammation and oxidative stress in the respiratory tract and lungs (Table 24; Figure D8 in Appendix D). Short-term SO_x exposure causes respiratory problems. The evidence is strongest for asthma exacerbation. Short-term exposures also may cause decreased lung function in people with underlying respiratory conditions. These impacts increase risk for respiratory death among people with respiratory conditions. Long-term SO_x exposure may lead to respiratory problems and contribute to asthma development as well as the severity of asthma in children. Exposure may also contribute to allergy development, increased susceptibility to respiratory infections, and respiratory-related death.

Table 24

Health outcomes resulting from Sulfur Oxides based on evidence to date		
Health outcome	**Short-term Exposure Impact**	**Long-term Exposure Impact**
Cardiovascular	Inadequate evidence	Inadequate evidence
Respiratory	Causal	Suggestive evidence
Nervous system	Inadequate evidence	Inadequate evidence
Reproductive system	Inadequate evidence	Inadequate evidence

Hazardous air pollutants (HAPs) include 187 air pollutants that the EPA knows or suspects to have serious health effects, such as cancer or birth defects. The greatest sources of HAPs related to airport activities are idling and taxiing aircrafts.[37] Road vehicles, ground support equipment, and stationary equipment like generators and AC units also contribute to airport HAPs. The EPA regulates HAPs by placing emissions standards on equipment (like vehicle engines) rather than monitoring air quality as is done for criteria air pollutants.

The Airport Cooperative Research Program (ACRP), authorized by Congress and sponsored by the Federal Aviation Administration to find solutions to issues airports face, concluded that the most important HAPs related to airport activities are:[49]

- formaldehyde;
- acrolein;
- 1,3-butadiene;
- naphthalene;
- benzene;
- acetaldehyde; and
- ethylbenzene.

Several other HAPs are emitted at airports, but the ACRP list prioritizes HAPs that have the highest emissions and are most likely to lead to serious health effects.[49] Formaldehyde, 1,3-butadiene, benzene; and acetaldehyde cause cancer while the remaining HAPs noted are likely to cause cancer. In the short term, most cause respiratory irritation, except benzene (see Appendix C for more details).

Lead (Pb) is both a HAP and a criteria air pollutant. Inhaled lead is absorbed from the lungs into the bloodstream, where it strongly inhibits nutrient absorption and is highly toxic for cell function in organ systems throughout the body, especially the brain. Lead also gets stored in the blood, bones, and tissues, where it can be released later, re-exposing the body many years after exposure. Lead is removed from vehicle fuel and commercial jets run on lead-free kerosene-based fuels, but many small piston-engine planes still use leaded-fuel. Piston-engine aircraft are the largest source of lead emissions in the U.S.[50] Lead emissions are primarily of concern near airports that serve small piston-engine planes (called “general aviation” airports). Airborne lead concentrations have been found higher than EPA standards over a half mile downwind of general aviation airports.[51] In addition to being inhaled, lead also settles out of the air into soils and dust, where it can be ingested by children.[52] Because lead does not break down in soils, children today also face exposure risk from high historical lead emissions related to aircraft, vehicle, and industrial activities.[53]

No safe threshold for lead exposure exists. The effects of even small amounts of lead are devastating for health. Lead exposure can cause a range of cognitive effects in children, such as lower IQ and issues with attention, impulse, executive function, hyperactivity, and school performance. Exposure also likely results in behavioral problems in children—internalizing problems such as depression and anxiety, and externalizing problems such as bullying and conduct disorders.[54] Motor function and hearing are also likely impacted by Pb exposures in children. Lead exposures in adults can cause hypertension and coronary heart disease,[55] and likely contributes to reduced immune system efficacy, depression and anxiety, and issues with cognitive function. Exposures can also cause delayed puberty and reduced reproductive function.

3. Who Is At Risk?

The type of exposure, amount of exposure, and length of exposure can all impact risk. Vulnerable populations such as those with underlying heart conditions, heart disease, and asthma are more likely affected by lower concentrations of air pollution and noise and more seriously affected by higher levels of pollutants. For example, on days with high air pollution concentrations, people with underlying conditions are more likely to suffer asthma attacks or heart attacks. Higher concentrations will also affect more people in the general population.

Risk of an adverse health outcome is not equal among everyone exposed to the same level of the same pollutant. Each person has their own unique mix of other exposures and individual characteristics, including stage of life or underlying health conditions, that shape their own risk or susceptibility. For example, children are especially susceptible to the effects of lead because they are more likely to ingest it, the same dose is larger relative to their body mass, and they are at a critical stage of development. Children also breathe two to three times faster than adults, so they may breathe in more pollutants. Older adults may be at increased risk for cancer-related health effects because they have had a longer time to accumulate more DNA damage. Noise sensitivity can vary by age, underlying medical/sleep conditions, work schedule, and noise insulation at home or work.

Underlying health conditions increase risk of more serious health effects. Someone with heart disease is at greater risk of more serious cardiac-related health effects from air and noise pollution exposures than someone without underlying heart health concerns. Beyond having an underlying health condition, increased activation of biological pathways (chronic stress, systemic inflammation, oxidative stress, DNA damage, and epigenetic changes) prior to noise or air pollution exposures increases risk of health effects from air and noise pollution exposures. These biological pathways can be activated by things like stressful life circumstances, restricted access to healthy foods, restricted opportunity for physical activity, unsafe working conditions, and inherited epigenetic changes related to these stressors.

The health risks of noise pollution and air pollution are not distributed evenly between communities near airports.[iv] Air pollutant exposures and noise levels vary across areas near airport activity (including flight paths and road traffic) over time, distance, local geography, and meteorological conditions. Risk of pollutant exposure is also related to socioeconomic status (SES) and race/ethnicity. Both individual SES and average SES of neighborhood independently impact health.[56] People of higher SES living in lower-SES neighborhoods have resources that may allow them to avoid or overcome health hazards from their neighborhood. For example, they may be able to insulate their homes to reduce their individual exposure to noise pollution. People of color are disproportionately represented among lower-SES groups in the U.S., and the systemic racism they face daily also adversely affects health.[57] These differences contribute to poorer health outcomes for people of lower SES, including higher rates of diabetes, heart disease, respiratory disease, and early death.

[iv] See for example https://fortress.wa.gov/doh/wtn/WTNIBL/.

People of color and people of lower SES face much higher health risks from air pollution and noise pollution compared to white people and people of higher SES.[6] They are more likely to live in neighborhoods with greater air and noise pollution exposures because these neighborhoods tend to have lower housing prices, and economic and racial segregation have resulted in discriminatory housing practices. Lower SES people are more likely to hold jobs where they are exposed to high noise levels, increasing baseline risk for effects from neighborhood noise pollution exposures. Many noise sensitivity factors, such as overnight shift work, sound insulation in buildings, and underlying medical or sleep conditions, are also likely to be more concentrated in lower-SES neighborhoods. People of color and people of lower SES are more likely to have underlying conditions like diabetes, heart disease, and respiratory conditions, and they are less likely to have access to appropriate health care. Epigenetic changes from exposures to previous generations may increase susceptibility to health effects from air pollution today.[58]

4. Are Communities Near Airports Exposed to Pollution Resulting from Airport Operations, and if So, How Much?

Not enough is known about people's exposure to airport-related noise and air pollution, likely because it can be difficult to assess and requires understanding the concentration of pollutants, duration of exposure, and in some cases infiltration of pollutants into biological systems. At an individual level, determining exposure requires either testing biologically to determine the level of pollutants in systems, or using personal, portable pollutant monitors to measure exposure as well as people's location when exposure occurred. Such studies are infrequent and time consuming; the more common approach is to use available information from existing ambient noise and air pollutant monitors and estimate people's exposure using residential addresses or similar data.

Noise Pollution

Multiple studies in the U.S. and other countries demonstrate higher noise levels related to airport operations and specifically aircraft.[7–9] Sound levels are measured in decibels (dB) based on human hearing, where 0 dB is barely audible and a food blender running 3 feet away is roughly 95 dB. A 10-unit increase in decibels is the same as roughly doubling the perceived sound level. Regulations for noise pollution usually apply to average noise levels over 24-hour periods (Ldn) with an adjustment made to lower the threshold for nighttime noise. An average noise level is limited however, and the maximum or peak sounds and how often they occur are important to health and have implications for lived experiences.[59]

Noise levels for the general public are no longer regulated at the federal level after the EPA's Office of Noise Abatement and Control was defunded in 1982. Prior to then, the EPA published guidelines advising that limiting outdoor Ldn to 55 dB and indoor Ldn to 45 dB was essential to protect people from activity interference and annoyance.[60] The Federal Aviation Administration (FAA) maintains that Ldn below 65 dB is compatible for schools and residential land use.[61] In 2018, the WHO revised guidelines for Europe to set aircraft noise thresholds at 45 dB during the day and 40 dB at night.[62] The WHO guidelines are health-based (i.e., recommendations based on protecting human health from exposure).

The WHO recommends that aircraft noise levels be reduced to 45 dB during the day and 40 dB at night because noise at higher than these levels can negatively impact sleep, children's learning, and health. For example, a cross-sectional study conducted in three nations of children in schools near airports found that reading performance declined with each increase of 5 dB of noise, after controlling for the level of school insulation and relevant family characteristics.[63]

The most recent completed study of local noise pollution in communities near the airport was the Beacon Hill Noise Measurement Project conducted in 2018.[64] Volunteer residents collected 24-hour periods of noise level information over 52 locations between April and September, as well as maximum

levels and how often they occurred. Of the 136 24-hour observation periods, over half of the 24-hour day-night average noise levels (Ldn) were over 65 dB. The maximum observed was 85.5 dB. Analyses of 1-second noise measurements across numerous days showed that noise levels exceeded 65 dB between 1% to 18% each hour between 3 a.m. and noon. A University of Washington undergraduate student collected observations to help assess noise levels related to aircraft versus ambient neighborhood noise and found that noise levels above 70 dB correlated with aircraft flying overhead. Noise levels without aircraft flying overhead were 45–55 dB. The student's observations of aircraft flights overhead aligned with noise levels recorded at a nearby Port of Seattle monitor.[v] University of Washington Seattle researchers, in partnership with El Centro de la Raza, are in the process of studying noise levels in the Beacon Hill community resulting from airplanes flying overhead.

Air Pollution

Multiple studies document elevated levels of air pollutants, specifically particulate matter and black carbon, near airports and/or underneath flight pathways. Researchers found higher levels of air pollutants near Los Angeles airport,[65,66] LaGuardia in New York,[67] Logan airport in Boston,[68,69] the Ciampino airport in Rome,[70] and the Schiphol airport in the Netherlands.[71] In 2016, observations of pollutant levels at Los Angeles International Airport (LAX) and major freeways showed higher particulate concentrations, $PM_{2.5}$ concentrations, and black carbon concentrations per day near the airport compared to the freeways (11, 1.4, and 2.5 times higher respectively).[65] At that time, particulate number was considered a proxy for UFP because methods to reliably measure UFP were developed within the past few years. A 2014 study showed that particulate concentrations downwind of LAX were four times higher than ambient levels five miles from the airport and twice as high as ambient levels 10 miles away.[68] Another study of LAX with data collected in 2017 showed similar levels of UFP that were between 1.1 and 4.8 times higher than that of ambient concentrations. Higher levels of UFP were associated with airport landings, and these elevated levels of UFP corresponded to the highest noise levels from aircraft overhead.[72]

The Puget Sound Clean Air Agency monitors and reports on regional air quality. Its 2019 data summary noted that fine particle matter levels were within EPA standards throughout the year but at higher than recommended levels for human health using the Agency's definition (25 $\mu m/m^3$) during at least 22 days during winter.[73] The 2018 report noted higher than recommended levels of particle matter and ozone during the year.[74]

Estimates reported by SeaTac airport for 2016 show that most airport-related air pollutant emissions that are regulated result from aircraft engines (Table 25). Lead levels are lower than the emissions estimates shown below; 2014 EPA data estimate 0.02 tons of lead emissions from SeaTac airport.[75] In comparison, King County airport activities resulted in 1.53 tons of lead emissions in 2014; 93% of these emissions came from Auburn and Renton municipal airports, Boeing Field, and Crest Airpark. Lead emissions may be higher at local airports other than SeaTac because the use of airplane fuel containing lead is higher.[vi] Typical ground transportation emissions (from people driving to and from the airport) tend to contribute CO, NO_x, VOCs, and PM emissions on a scale similar to aircraft emission sources in immediate proximity to the roadway.[36]

[v] For Port of Seattle noise monitoring information, see https://www.portseattle.org/page/aircraft-noise-monitoring-system.

[vi] For more information about aircraft fuels containing lead, see the Federal Aviation Administrations' 2019 Fact Sheet – —Leaded Aviation Fuel and the Environment at https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=14754.

Table 25

Criteria Pollutant Emissions Inventory, 2016 Seattle-Tacoma International Airport						
Emission Source	**NO_x**	**VOC**	**CO**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**
Aircraft Engines	1,775	261	1,455	162	13	13
Auxiliary Power Unit	40	3	33	5	5	5
Ground Support Equipment	370	94	2,769	19	25	25
Stationary Sources	18	1	12	0	1	1
Parking	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ground Transportation	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total	2,267	379	4,841	190	48	47
n.a.=not available Source: Landrum & Brown using the FAA's AEDT Version 2c Service Pack 2, Sept 2017.						

As mentioned previously, UFP is not regulated and therefore not systematically monitored, though understanding UFP is critical for communities near airports because aircraft exhaust emissions are largely carbon-based UFP. The first study measuring UFP emissions from aircraft traffic near SeaTac Airport was completed in 2019 and is reviewed in section IV of this report.[76]

PM from airplane exhaust is likely present indoors as well as outdoors. A recent study of air pollutant concentrations outdoors and indoor in a residence representative of neighborhood housing structures and under Boston Logan International Airport's flight paths demonstrated that outdoor pollutants penetrated indoors within minutes, indoor and outdoor concentrations were similar (suggesting that penetration is substantial), concentrations were greater during landings than takeoffs, and indoor concentrations were higher than those reported by area outdoor monitoring stations.[77]

Because it is not possible to conduct randomized experiments to study airport-related air pollutant exposures and confounders such as noise levels are common, modeling is used to examine the impact of exposure on population health. For example, researchers recently modeled the number of children in schools near seven California airports who were exposed to airport-related air pollutants by calculating when children in school were downwind of the airport.[78] They estimated that 8.7% of children were exposed to airport-related air pollutants for an hour or more per day. A greater proportion of economically disadvantaged children (10.6%) were exposed an hour or more per day. One estimate of the number of deaths attributable to aircraft emissions at cruising altitude was 8,000 per year but did not factor in emissions from takeoffs and landings.[79] A more recent estimate attributed roughly 16,000 deaths per year globally to aircraft emissions and showed that CO and NO_2, along with contrails, were significant contributors to reduced air quality and should be targeted for reduction.[80] An FAA-sponsored study estimated 160 deaths annually from aircraft $PM_{2.5}$ emissions during takeoff and landing between the 325 U.S. airports studied from 2005 to 2006.[81] The same study estimated that SeaTac aircraft $PM_{2.5}$ emissions during landing and takeoff made up approximately 0.25% of all $PM_{2.5}$ emissions in the Seattle-Tacoma region and 0.87% of all $PM_{2.5}$ from mobile sources in the region.[81] The most recent local estimate is from a 2017 study of 66 major airports, which estimated roughly 0.7 deaths annually to SeaTac emissions and 0.1 deaths annually from Boeing Field emissions, primarily from $PM_{2.5}$ and pollutants that form $PM_{2.5}$.[82]

Many of the health effects reviewed may take place at exposure levels below the EPA standards, especially the effects of $PM_{2.5}$,[83–85] A few recent studies have estimated over 100,000 early deaths per year in the US from $PM_{2.5}$.[83,86] A cohort study of U.S. veterans estimated risk of $PM_{2.5}$ exposure based on county-level measurements and modeled the relationship to cause-specific death rates; the authors found that 99% of the estimated burden of death from nonaccidental causes was associated with

exposures under the EPA standards.[87] A number of researchers argue that the $PM_{2.5}$ standard should be much lower than it is.[85,88]

The EPA standards and monitoring process is not designed to protect neighborhoods closest to emission sources. The EPA regulates ambient concentrations of most of the air pollutants reviewed, and local concentrations are likely higher than regulation levels. Apart from lead emissions, EPA monitors are generally not intended to monitor local areas of highest concentrations; the monitors tend to be located where they can measure background concentrations.[89] Even when those monitored concentrations are within EPA standards, communities closer to sources of these air pollutants will be exposed to higher concentrations than what the monitors reflect. As mentioned previously, these communities tend to have greater populations of people of color and higher rates of poverty.[90] For example, a 2010 study measuring street-level pollutants in Seattle's International District found much poorer air quality than that measured by the nearest air quality monitoring station a mile away.[91]

5. What Do We Know about Mitigating Airport Related Pollutants?

Evidence about what works in mitigating airport-related pollutants is also somewhat limited. Most of the relevant research explores the effectiveness of filtration systems, airport operation designs, alternative fuels, and use of green space. Recent findings are summarized below.

Building seals and effective filtration systems will prevent exposure to pollutants and disruptive noise. Because people spend most of their time indoors, most of their exposure to particulate matter and other air pollutants happens indoors. Removal of particulates/air pollutants indoors is dependent on the quality of heating, ventilating, and air-conditioning (HVAC) systems. HVAC filtration standards are based on the ability to remove particulates by size, represented by a minimum efficiency removal value (MERV). This current standard does not address the ability to filter out UFP.[92] A 2014 analysis of HVAC filtration systems suggests that $PM_{2.5}$ and UFPM removal efficiency increases with higher MERV; the percentage of particulate matter removed was a median of 71% for $PM_{2.5}$ for MERV14, and was near 100% for HEPA filters.[93] The ASHRAE filtration standard for schools following the COVID-19 outbreak is MERV13, which is expected to remove, on average, a minimum of 75% of particles having a size of 0.3–1.0 µm (UFPs).[94] Ensuring that buildings have high efficiency filtration systems will help reduce exposure to air pollutants.[95–97] One estimate suggests that use of high-efficiency filters will reduce premature mortality by up to 2.5% and increase life expectancy by 0.02–1.6 months.[98] Building construction, specifically window type and heating system, was related to the levels of indoor pollutants relative to outdoor levels of pollutants in one study.[99]

Having high-efficiency filtration systems and sealed buildings may not be enough, however, to reduce people's exposure. A six-week, randomized, crossover study of 23 low-income homes in urban areas (Boston and Chelsea, MA) showed that high-efficiency particulate air (HEPA) filtration reduced particulate number concentrations by 50–85% but did not reduce inflammation in people, perhaps because of longer-term exposures (carry-over effects) and/or residents opening windows.[100] Researchers in Denmark found in an experimental study that human behavior had as large an impact on indoor PM concentrations as did a particulate filtration system.[101] Similarly, one study showed that using personal air monitors increased awareness of where air pollution occurs and its effects, but providing personal air monitors was insufficient for changing people's behaviors to minimize exposure.[102]

Airport departure and arrival operation changes can reduce pollution. Airport departure designs that minimize the time planes idle or taxi, use steeper takeoff trajectories, and optimize engine thrust can help reduce emissions and noise pollution. Holding at the gate rather than having planes taxi can reduce emissions.[103] Research conducted at the Detroit, MI airport showed that holding planes at the gate for 25 minutes or so to reduce congestion reduced emissions by 35–38% relative to no gate holds.[104] Taking off at 81% thrust instead of full thrust reduced emissions in one study.[105] Local data has been used to plan and test departure and arrival patterns to reduce noise pollution.[106]

Alternative biofuels can also reduce emissions, as long as thermodynamic efficiency of engine combustion remains the same or improves. One experiment showed that blending biofuel with conventional fuel reduced the amount of particulate emissions during flight by 50–70%.[107] Scientists recently developed an approach to convert plant waste (specifically the cellulose) into plane fuel with higher heat values than conventional plane fuel.[108] Higher volumetric heat values (referred to as higher-density fuel) mean that the same volume of fuel gives the plane more range, which then is likely to reduce CO_2 emissions.

Green space, specifically coniferous tree coverage, is associated with lower concentrations of particulate matter, though the mechanisms and effects are complex and appear to depend on factors including leaf structure, scale, and region, among other considerations.[109] For example, a study in Finland found only slight or insignificant effects of trees on concentrations of particulates, NO_2, and VOCs.[110] A recent study of five cities in China showed that more tree coverage and grass coverage is correlated with lower $PM_{2.5}$ concentrations in neighborhood green spaces greater than 200 m^2 but not necessarily smaller areas.[111] In that study, total green space and tree coverage had a stronger relationship with lower $PM_{2.5}$ concentrations than did grass coverage. PM accumulates on the surface or hairs and in the wax of leaves, thus the ability to capture PM deposits depends on the type of tree leaf. Leaves with more hairs on top and lower specific areas (leaf area/leaf mass; i.e., smaller, thicker leaves) capture more PM than do hairless leaves.[112,113] In a few studies, coniferous trees captured more PM than broadleaf trees.[112,114–116] Green spaces did not reduce gaseous air pollutants at the same levels they reduced PM in at least one study,[117] and analyses of urban forests in Florida showed marginal reductions in CO_2 emissions.[109]

IV. WHAT WERE FINDINGS FROM THE UNIVERSITY OF WASHINGTON PUBLIC HEALTH STUDY OF ULTRA-FINE PARTICULATES?

Report Requirement 3: Findings of the University of Washington School of Public Health study

> Proviso language: The findings of the University of Washington School of Public Health school of public health study on ultrafine particulate matter at the airport and surrounding areas

A. SUMMARY

Researchers with University of Washington's Environmental and Occupational Health Sciences Department conducted the first study of UFP concentrations near SeaTac airport during 2018–19.[118] They observed amounts of UFP, CO_2, and black carbon 10 miles south and north of the airport using fixed and mobile monitors in 2019. They found that both air and ground traffic increased UFP concentrations, though the size distributions of UFP and concentrations of black carbon differed by source. Monitors below air traffic flight paths showed higher concentrations of ultra UFP (10–20 nanometers), with the highest concentrations associated with landings compared to departures. Monitors near I-5 and SR 99 South showed higher concentrations of larger UFP and black carbon. The fixed site monitors showed higher concentrations of black carbon and UFP in fall and winter compared to spring and summer months. Findings support the conclusion that communities underneath and downwind of the flight path are exposed to aircraft-related UFP concentrations.

B. EXCERPT FROM EXECUTIVE SUMMARY OF MOBILE OBSERVATIONS OF ULTRAFINE PARTICLES STUDY REPORT[12]

The Mobile ObserVations of Ultrafine Particles Study (MOV-UP) is a two-year project funded by Washington State to analyze potential air quality impacts of ultrafine particles from aircraft traffic for communities near and underneath Seattle-Tacoma International Airport (SeaTac) flight paths. The study assessed ultrafine particle concentrations (UFPs) within 10 miles of the airport in the directions of

aircraft flight. The University of Washington research team that led the study designed the project to investigate the implications of aircraft traffic at SeaTac by (1) assessing the concentrations of UFPs in areas surrounding and directly impacted by aircraft traffic; (2) distinguishing and comparing UFP concentrations attributable to aircraft-related and other sources; and (3) coordinating with local governments, and sharing results and soliciting feedback from community stakeholders. Over the course of four seasons, we conducted both fixed-site and mobile sampling schemes to collect time-resolved measures of UFP, carbon dioxide (CO_2), and black carbon (BC) concentrations, and UFP size distributions.

This study primarily found that UFPs derive from both roadway traffic and aircraft sources, with the highest UFP counts found nearest major roadways (Interstate 5). Total concentrations of UFP alone (10–1,000 nm) did not distinguish roadway and aircraft features.

However, key differences exist in the particle size distribution and the black carbon concentration for roadway and aircraft features. These differences can help distinguish between the spatial impact of roadway traffic and aircraft UFP emissions using a combination of mobile monitoring and standard statistical methods.

Fixed-site monitoring confirms that aircraft landing activity is associated with a large fraction of particles in the range of 10–20 nm (ultra UFP). Mobile-derived fuel-based emissions factors (# ultra UFP/kgFuel) are consistent with differences in emissions between aircraft and roadway vehicles. The MOV-UP study findings demonstrate two clear and consistent spatial features of ultrafine particles independently associated with vehicle traffic and aircraft emissions.

V. RECOMMENDATIONS TO ADDRESS HEALTH ISSUES

Report requirement 4: Recommendations to address health issues

Any recommendations to address health issues related to the impact of the airport on the community

To address the health disparities of airport communities, we recommend the following:

- Implement focused efforts to address the health disparities of airport communities, including mitigating the health impacts of airport operations
    - Ensure participatory community engagement (particularly from Black/African American, Hispanic/Latino, and other communities of color who are disproportionately impacted) in plans and efforts to address the health of airport communities.
    - Increase culturally and linguistically appropriate prevention and disease management efforts in airport communities to address health disparities with emphasis on:
        - Preventing and treating chronic conditions (such as cancer, heart disease, diabetes, and chronic lower respiratory diseases) and unintentional and intentional injuries.
        - Ensuring healthy births, including improving access to culturally and linguistically appropriate prenatal and postnatal care.
    - Ensure that children and young adults are thriving by providing quality education and equitable opportunities for learning.
    - Increase awareness of the risks associated with airport-related air and noise pollution and the ways to prevent or mitigate the risks (e.g., appropriately sealed and ventilated residences and buildings).

- Continue development and implementation of strategies to mitigate airport-related air and noise pollution. These include:
    - Working with community residents and residential property owners to support healthy housing conditions (e.g., adequate ventilation and effective sealing of residences) through mitigation packages.
    - Ensuring a safe physical environment of childcare settings, schools, community centers, and long-term care facilities to protect vulnerable populations (e.g., adequate ventilation and effective sealing of buildings).
    - Continuing to improve airport operations to reduce noise and emissions on neighboring communities through technological and operational controls and through voluntary or regulatory policies aimed at reducing airport-related emissions.
    - Promoting healthy habitats by creating green spaces, specifically coniferous tree coverage, to capture particulate matter, thereby reducing people's exposure.
- Expand the systematic monitoring of pollutants (both outdoor and indoor exposures), including the implementation of new technologies to improve measurement of exposures indoors and outdoors. Understanding how pollutants penetrate not only residences but also schools, childcare, and long-term health facilities is critical to reducing people's exposure.
    - To better understand noise pollution, systematically measure the maximum or peak noise levels resulting from airport operations and the occurrence with which noise levels are above health-based standards.
    - Increase the number of fixed and mobile air quality measurements to create a network of regular monitoring to understand the spatiotemporal distribution of air pollution in the environment.[119]
    - Measure noise and air pollution in the communities proximal to the airport, since regional monitoring data can be lower than levels experienced closer to airport operations.
- Support further research to address gaps in knowledge, especially concerning levels of pollutant exposure resulting from airport operations, indoors and outside, and the precise mechanisms and degree of harm. Areas of future research include, but are not limited to:
    - The extent to which outside pollutants infiltrate indoor settings, i.e., residences, childcare settings, community centers, and long-term care facilities;
    - The impact of sound exposure levels on human health and quality of life, especially child and adult cognition, and the pathways through which noise pollution affects health; and
    - The mechanisms and nature of ultrafine particle (UFP) effects on human health.

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Appendices

Appendix A: Community Health Profile Methods
Appendix B: Community Health Profile Additional Data
Appendix C: Strength-of-Evidence Analysis Methods and Annotations
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Appendix A. Community Health Profile Methods

Appendix A. Community Health Profile Methods

How Zones Were Defined for Analysis

The airport communities included Zone A (less than 1 mile from the Seattle-Tacoma International Airport [SeaTac]), Zone B (1 to less than 5 miles from the airport) and Zone C (5 to 10 miles from the airport), to meet the requirements of the proviso. Balance of County, the area within King County more than 10 miles from the airport, is the non-overlapping comparison area. The zones overlap the census tract areas with the greatest average number of flights per day based on 2018 SeaTac flight data (Figure A1). Appendix B provides King County average rates and confidence intervals.

Datasets consisted of individuals' health events (e.g., birth risk factors, deaths) or survey responses (e.g., Behavioral Risk Factor Surveillance survey). Depending on the data source, either census tract or ZIP code of residence of the individual was usually the smallest geographic unit available. For these datasets, a census tract or ZIP codes was considered in a Zone if 50% or more of its area lay in the Zone. Accordingly, King County tracts or ZIPs that lay outside 10-mile radius—that is, outside of the outer boundary of Zone C—were assigned to Balance of County. Census tract and ZIP code overlay with Zone were calculated using geocoding packages in R (see Table A2 for zip codes by zone).[1–5]

We did not have residential information from students who took part in the Healthy Youth Survey (HYS) or for students in datasets from the Office of the Superintendent of Public Instruction (OSPI). For these sources, data was available by school building. To create Zone aggregates:

1. A file with the latitude and longitude of each King County public school was downloaded from the Washington Geospatial Open Data Portal.[6]
2. The latitude and longitude of each school were assigned to the appropriate Zone or Balance of County using geocoding software.
3. All HYS respondents or OSPI table counts from the school were assigned to the Zone in which the building was located.

Unstable Rates

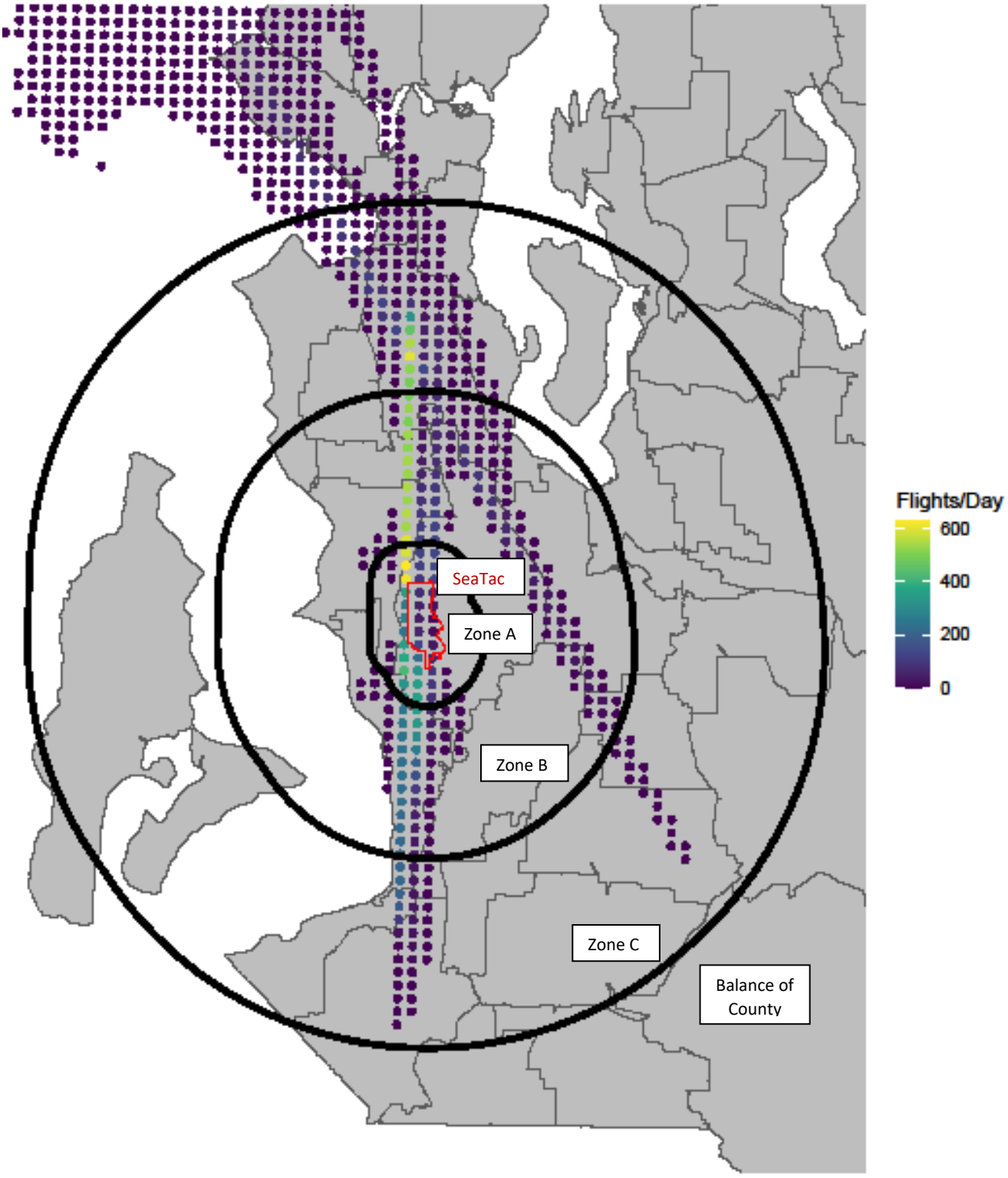
We flagged rates as unstable in data tables if the relative standard error—the rate standard error divided by the rate—was >30%. This is the guideline followed by the Public Health – Seattle & King County's (PHSKC) Assessment, Policy Development and Evaluation unit.

Data Suppression for Confidentiality

Use of some datasets in the report was governed by data sharing agreements that required the user to suppress rates to protect confidentiality. When data was suppressed, the table cell was noted with the "^^" symbol. The details of cell suppression requirements are as follows:

- The HYS data sharing agreement states: "Generally, if there are at least 3 schools and 3 school districts at a geographical level for which data are being reported, the schools and school districts are not identifiable."[7] Zone A did not meet this requirement; thus results for Zone A were suppressed for HYS indicators.
- The Washington State Department of Health (DOH) small numbers standard requires that rates and other information based on numerators between 1 and 9 be suppressed for certain population data.[8] This applied to measures derived from datasets for births, deaths, and hospitalizations.
- Hospitalization data included hospitalizations of Washington residents in Oregon for complete counts. Oregon data suppression rules require data to be suppressed if numerators are less than 10.

Figure A1
SeaTac Average Flights per Day in 2018 and Community Health Profile Zones



Leading Causes of Death

We identified leading causes by ranking cause of death for each of seven race groups in King County. We included a cause if it was among the 10 leading causes for any race. In the Leading Causes of Death table, the causes are listed in the order of their rank in King County as a whole. For instance, after all cause mortality, cancer was listed next because it has the most deaths of any specific cause of death in King County. Leading causes of death by race/ethnicity for King County can be found in PHSKC's Community Health Indicators report online.[9]

Excess Deaths

We adapted our method from a CDC report,[10] though we made some changes to work with local data. As in the CDC report, deaths in people age 80 and older were omitted from all calculations. We used 79 as the upper age boundary for potentially preventable deaths, since it is close to the King County average life expectancy (81.7 years, 2014–18 average).

We calculated age-standardized mortality ratios (SMRs) and observed and expected deaths using established methods.[11,12] To standardize by age, for each cause of death, we calculated observed and expected deaths for eight 10-year age groups (0–9, 10–19, … 70–79) for the Zones and Balance of County. We summed observed and expected deaths over age groups to arrive at the total observed and expected counts. The SMR was the total observed divided by the total expected.

If the lower limit of the SMR confidence interval (CI) was greater than 1, the SMR and excess deaths were significantly elevated. The choice of CI calculation method depended on the number of observed deaths. If there were fewer than 100 deaths, we calculated a CI for observed deaths using the Poisson distribution. The SMR's lower CI was the lower CI of the observed number divided by expected. If there were 100 or more deaths, we calculated a CI for the SMR following DOH assessment guidelines.[13] A negative number of excess deaths was set to 0.

Data Analysis

Data management, analysis, and table production were conducted with R.[1,4,14] DOH's Community Health Assessment Tool (CHAT) was used to provide grouped geographic units for Zone calculations, and provided counts, populations, rates, standard errors, and confidence intervals used in calculations for births, deaths, and hospitalizations.

Hospitalization and death rates were age-adjusted (except where noted) per 100,000 population. Rates for birth risk factors, educational attainment, high school graduation, poverty and foreign born, and measures derived from the Healthy Youth Survey and the Behavioral Risk Factor Surveillance survey were given in percentages and not age-adjusted. All counts were average yearly counts. For counts from surveys, we rounded to the nearest hundred to account for survey error. Otherwise, average yearly counts were rounded to the nearest integer. For some measures, counts could not be accurately calculated and were noted as "N/A."

In measures from the Healthy Youth Survey, to assess the potential confounding effect of grade in comparisons between a zone and Balance of County, we stratified by grade. Because the stratified comparisons were consistent with unstratified comparisons, the unstratified rates and comparisons are presented in the profiles.

Differences were considered statistically significant when 95% confidence intervals for rates did not overlap. We grouped data from 2014 to 2018 together to stabilize rates if these years were available. Otherwise, we grouped other recently available years (Table A1).

Table A1 Measures by Data Source and Years of Analysis		
Measure	**Source**	**Years analyzed**
Population estimates by age group	Washington State Office of Financial Management, Forecasting Division, single year intercensal estimates 2001–19, Community Health Assessment Tool (CHAT), March 2020	2014–18
Population estimates by race		
Near poverty and poverty	American Community Survey, https://www.census.gov/programs-surveys/acs/, Table B17024	2014–18
Adult educational attainment	American Community Survey, https://www.census.gov/programs-surveys/acs/, Table B15003	2014–18
Foreign born	American Community Survey, https://www.census.gov/programs-surveys/acs/, Table B05002	2014–18
Uninsured (age 19–64)	American Community Survey, https://www.census.gov/programs-surveys/acs/, Table B27001	2014–18
Met 3rd grade reading standard	Office of the Superintendent of Public Instruction public use tables, https://data.wa.gov/Education/Report-Card-Assessment-Data-2018-19-School-Year/5y3z-mgxd, accessed 8/2020.	2018–19
High-school graduation rate		
Adequate prenatalprenatal care	Washington State Department of Health, Center for Health Statistics, Birth Certificate Data, 1990–2018, Community Health Assessment Tool (CHAT), October 2019	2014–18
Premature births		
Low birth weight		
Child overall health status	King County Best Starts for Kids Health Survey	2017, 2019
Child did not receive needed health care		
Children with a caregiver with inadequate sleep		
Dental checkup: none in the last year	Washington State Healthy Youth Survey	2016, 2018
Current cigarette smoking		
Current e-cigarette or vape pen use		
Met physical activity recommendations		
Obese		
Depression (school age)		
Health status fair/poor	Washington State Department of Health, Center for Health Statistics, Behavioral Risk Factor Surveillance System, supported in part by the Centers for Disease Control and Prevention, Cooperative Agreement U58/DP006066-05 (2019)	2014–18
Could not see doctor due to cost		
Current smoker		
High blood pressure		
Obese		
No physical activity in leisure time		
Inadequate sleep		2013, 2014,

Table A1 Measures by Data Source and Years of Analysis		
Measure	**Source**	**Years analyzed**
		2016, 2018
Has asthma now (prevalence)	Washington State Department of Health, Center for Health Statistics, Behavioral Risk Factor Surveillance System, supported in part by the Centers for Disease Control and Prevention, Cooperative Agreement U58/DP006066-05 (2019)	2014–18
Ever had stroke		
Ever had heart attack		
COPD (prevalence)		
Diabetes (prevalence)		
Depression (adults)		
Asthma, child and adult (hospitalization)	Washington Hospital Discharge Data, Comprehensive Hospitalization Abstract Reporting System (CHARS) 1987–2018. Washington State Department of Health, Center for Health Statistics, Community Health Assessment Tool (CHAT), July 2019	2016–18
Cerebrovascular disease (stroke hospitalization)		
COPD (hospitalization)		
Diabetes (hospitalization)		
Diseases of the heart		
Life expectancy	Washington State Department of Health, Center for Health Statistics, Death Certificate Data, 1990–2018, Community Health Assessment Tool (CHAT), October 2019	2014–18
Leading causes of death		
Leading causes of cancer death		
Leading causes of unintentional injury death		
Excess and potentially preventable deaths		

Table A2 Zip Codes by King County Zone				
Zone A	**Zone B**	**Zone C**	**Balance of County**	
98148	98032	98002	98004	98107
98158*	98198	98003	98005	98109
	98055	98001	98007	98112
	98057	98006	98008	98115
	98166	98070	98010	98117
	98188	98030	98014	98119
	98146	98031	98024	98121
	98168	98040	98027	98122
	98178	98056	98029	98125
		98058	98033	98199
		98059	98034	98155
		98104	98038	98177
		98126	98039	98195
		98106	98042	98224
		98108	98045	98288

Table A2 Zip Codes by King County Zone				
Zone A	**Zone B**	**Zone C**	**Balance of County**	
		98116	98051	98011
		98118	98052	98028
		98134	98053	98077
		98136	98065	98072
		98144	98074	98022
		98023	98075	98019
			98101	98047
			98102	98092
			98103	98133
			98105	

* ZIP code 98158 is for SeaTac Airport and has 0 residential population.

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Appendix B. Community Health Profile Additional Data

Appendix B. Community Health Profile Additional Data

Table B1 Population Estimates by Race/Ethnicity and Age Group by Zone, Balance of County and King County, 2014–18 annual average										
Categorical Group	Zone A		Zone B		Zone C		Balance of County		King County	
Total	30319	100%	260163	100%	605546	100%	1207782	100%	2103810	100%
Age										
Under 18	6944	23%	60202	23%	138221	23%	235712	20%	441079	21%
18 to 24	2922	10%	22250	9%	49405	8%	111731	9%	186308	9%
25 to 44	9744	32%	79124	30%	178513	29%	409925	34%	677307	32%
45 to 64	7064	23%	65759	25%	159739	26%	306420	25%	538981	26%
65 and over	3645	12%	32828	13%	79668	13%	143994	12%	260134	12%
Race/Ethnicity										
American Indian/Alaska Native	280	1%	2003	1%	3530	1%	7573	1%	13386	1%
Asian	4095	14%	50289	19%	117565	19%	172659	14%	344609	16%
Black or African American	5064	17%	34887	13%	57406	9%	36574	3%	133930	6%
Hispanic/Latinx	6871	23%	46111	18%	67244	11%	88627	7%	208854	10%
Multiple race	1358	4%	12752	5%	29778	5%	51902	4%	95790	5%
Native Hawaiian/Pacific Islander	1113	4%	4986	2%	6815	1%	4356	0%	17270	1%
White	11538	38%	109134	42%	323208	53%	846092	70%	1289971	61%

Table B2[1]
Measures by Area by Zone, Balance of County, and King County

Indicator	Zone A				Zone B				Zone C				Balance of County			King County		
	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI
Percent in households living at less than 200% of the federal poverty level by age																		
Total population	37.2%	11,500	34.4%	39.9%	31.7%	84,100	30.8%	32.7%	24.4%	148,800	23.8%	25.0%	16.1%	15.8%	16.4%	20.7%	20.5%	21.0%
Under 18 years	51.1%	3,800	44.2%	57.9%	46.7%	27,800	44.1%	49.3%	33.5%	44,200	31.9%	35.2%	14.6%	13.8%	15.4%	25.2%	24.5%	26.0%
Educational attainment, age 25 or older																		
Associate degree or more+	28.1%	6,100	25.7%	30.5%	38.6%	71,700	37.7%	39.5%	51.4%	222,800	50.7%	52.0%	68.7%	68.2%	69.2%	59.6%	59.2%	60.0%
Child educational success																		
High school graduation rate	80.7%	NA	74.4%	85.8%	72.3%	NA	70.3%	74.3%	81.0%	NA	80.1%	81.9%	87.7%	87.1%	88.4%	82.7%	82.2%	83.2%
Met 3rd grade reading standard	43.4%	NA	38.0%	49.0%	39.0%	NA	37.1%	41.0%	54.6%	NA	53.4%	55.8%	73.3%	72.5%	74.1%	62.9%	62.3%	63.6%
Foreign born																		
Foreign born	35.9%	11,500	33.1%	38.7%	27.1%	72,600	26.2%	28.1%	23.9%	147,500	23.3%	24.4%	20.5%	20.1%	20.8%	22.5%	22.3%	22.7%
Birth risk factors																		
Early and adequate prenatal care	63.9%	300	60.7%	67.2%	68.8%	2367	67.6%	70.0%	71.1%	5042	70.2%	71.9%	75.0%	74.4%	75.7%	72.6%	72.1%	73.1%
Low birth weight (singleton)	5.8%	28	4.9%	6.8%	6.1%	217	5.8%	6.5%	5.5%	400	5.3%	5.8%	4.7%	4.5%	4.8%	5.2%	5.1%	5.3%
Premature births (singleton)	9.8%	48	8.6%	11.1%	9.4%	334	9.0%	9.9%	8.2%	593	7.9%	8.5%	6.6%	6.4%	6.8%	7.6%	7.4%	7.7%
Children: Overall health status, access to care, and risk factors																		
Child overall health status excellent or very good	88.4%	NA	82.4%	94.4%	82.9%	NA	79.4%	86.4%	86.5%	NA	84.3%	88.6%	92.1%	90.9%	93.4%	88.9%	87.9%	90.0%
Child did not receive needed health care	6.1%	NA	1.6%	10.6%	6.1%	NA	3.8%	8.5%	3.8%	NA	2.7%	4.8%	2.9%	2.1%	3.6%	3.7%	3.1%	4.3%
No dental checkup in last year	^^	^^	^^	^^	19.2%	NA	16.8%	21.7%	16.9%	NA	15.6%	18.2%	11.8%	11.1%	12.6%	14.5%	13.7%	15.2%
Current cigarette smoking	^^	^^	^^	^^	5.2%	NA	4.0%	6.8%	5.2%	NA	4.5%	5.9%	4.4%	4.0%	5.0%	4.8%	4.4%	5.2%

[1] ^^: Data suppressed to meet confidentiality standard.
NA: Estimated counts were not available for these measures.

Table B2[1]
Measures by Area by Zone, Balance of County, and King County

Indicator	Zone A				Zone B				Zone C				Balance of County			King County		
	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI
Current e-cigarette or vape pen use	^^	^^	^^	^^	11.3%	NA	9.1%	13.9%	12.8%	NA	11.5%	14.2%	14.4%	13.0%	16.0%	13.5%	12.6%	14.5%
Obese	^^	^^	^^	^^	15.2%	NA	13.3%	17.2%	12.2%	NA	11.0%	13.5%	7.5%	7.0%	8.1%	10.1%	9.4%	10.8%
Met physical activity recommendations	^^	^^	^^	^^	18.2%	NA	16.3%	20.2%	19.6%	NA	18.4%	20.7%	21.3%	20.4%	22.2%	20.3%	19.6%	20.9%
Adults: Overall health status, access to care, and risk factors																		
Health status fair/poor	25.5%	6000	13.7%	42.4%	15.7%	31500	13.4%	18.3%	14.9%	69500	13.4%	16.5%	10.0%	9.1%	10.9%	12.0%	11.3%	12.7%
Uninsured (age 19–64)	14.3%	2800	12.3%	16.4%	13.8%	23200	13.0%	14.6%	5.8%	48400	5.6%	6.0%	7.8%	7.6%	7.9%	7.8%	7.6%	7.9%
Could not see doctor due to cost	26.3%	6100	14.3%	43.3%	14.1%	28200	11.8%	16.8%	11.3%	53000	10.0%	12.9%	9.8%	8.9%	10.7%	10.8%	10.1%	11.6%
Current smoker (adult)	8.2%	1900	2.6%	23.4%	17.7%	35400	15.0%	20.8%	12.1%	56700	10.7%	13.7%	9.5%	8.6%	10.5%	11.1%	10.4%	11.9%
High blood pressure	27.3%	6400	13.5%	47.3%	29.3%	58500	26.0%	32.7%	28.3%	132300	26.3%	30.5%	23.6%	22.3%	24.9%	25.4%	24.4%	26.5%
Obese	44.3%	10300	28.8%	61.0%	29.2%	58300	26.0%	32.5%	24.4%	113900	22.6%	26.2%	19.1%	18.0%	20.2%	21.5%	20.6%	22.5%
No physical activity in leisure time	31.7%	7400	18.4%	48.9%	20.5%	41000	17.7%	23.6%	17.5%	81600	15.7%	19.3%	12.1%	11.2%	13.1%	14.6%	13.7%	15.4%
Inadequate sleep	33.5%	7800	18.9%	52.1%	34.5%	69000	30.7%	38.6%	35.0%	163700	32.5%	37.6%	27.0%	25.5%	28.6%	30.1%	28.9%	31.3%
Child with a caregiver with inadequate sleep	28.9%	1600	15.1%	42.7%	35.1%	12700	29.6%	40.5%	30.1%	22900	26.5%	33.6%	27.3%	24.2%	30.5%	29.3%	27.1%	31.5%
Chronic conditions: prevalence, and hospitalization																		
Prevalence																		
Has asthma now	5.6%	1300	1.8%	16.1%	8.2%	16400	6.5%	10.3%	10.0%	46600	8.7%	11.4%	8.3%	7.6%	9.2%	8.7%	8.1%	9.4%
Ever had stroke	2.8%	600	0.6%	11.3%	3.4%	6900	2.3%	5.2%	3.1%	14600	2.4%	4.1%	1.9%	1.6%	2.3%	2.4%	2.0%	2.7%
Ever had heart attack	2.7%	600	0.9%	7.8%	3.6%	7100	2.5%	5.0%	3.4%	16000	2.7%	4.4%	2.5%	2.2%	3.0%	2.9%	2.5%	3.3%
Chronic obstructive pulmonary disease	2.9%	700	0.7%	11.6%	4.8%	9600	3.7%	6.3%	4.1%	19300	3.3%	5.1%	3.3%	2.9%	3.9%	3.7%	3.3%	4.1%

Table B2[1]
Measures by Area by Zone, Balance of County, and King County

	Zone A				Zone B				Zone C				Balance of County			King County		
Indicator	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI
Diabetes	12%	2800	6%	22%	10%	19800	8%	12%	8%	38200	7%	9%	6%	6%	7%	7%	7%	8%
Depression (school-age)	^^	^^	^^	^^	34.4%	NA	32.8%	36.1%	33.5%	NA	32.2%	34.9%	29.4%	28.4%	30.4%	31.4%	30.6%	32.1%
Depression (adults)	11.3%	2600	5.1%	23.3%	20.5%	40900	17.9%	23.3%	22.2%	103600	20.4%	24.0%	21.5%	20.4%	22.8%	21.3%	20.4%	22.2%
Hospitalization (rate/100,000)																		
Asthma (adult)	^^	^^	^^	^^	28.4	^^	24.16	33.14	28.51	^^	25.9	31.4	16.6	15.1	18.1	21.6	20.4	22.9
Asthma (child)	^^	^^	^^	^^	100.2	^^	85.5	116.6	86.9	^^	78.5	95.9	71.3	65.3	77.9	82.2	77.4	87.2
Cerebrovascular diseases (stroke)	304.8	17	240.5	382.6	270.3	413	258.5	282.5	241.9	981	235.0	248.9	213.0	208.0	218.1	228.1	224.4	232.0
COPD	81.7	5	51.2	125.9	59.4	94	54.1	65.2	68.3	286	64.8	72.1	52.3	49.9	54.8	58.3	56.4	60.2
Diabetes total	179.7	10	133.0	239.5	133.2	202	125.0	141.9	102.5	414	98.0	107.1	70.7	67.9	73.5	NA	NA	NA
Diseases of the heart	876.5	48	764.5	1001.6	600.4	918	582.8	618.4	520.5	2134	510.4	530.6	463.3	456.0	470.8	498.1	492.6	503.7
Life expectancy and leading causes of death																		
Life expectancy (in years)	77.9	77.1	78.6	79.4	79.2	79.7	81.2	81.1	81.4	82.9	82.8	83.0	81.7	81.6	81.8	77.9	77.1	78.6
Cause of death																		
All	808.6	248	763.0	856.5	723.4	1901	708.6	738.3	639.1	3950	630.1	648.3	572.2	566.0	578.5	621.4	616.5	626.3
Cancer	158.7	48	138.8	181.0	160.9	428	154.0	168.0	138.6	878	134.5	142.9	135.3	132.3	138.4	140.6	138.3	143.0
Diseases of heart	187.7	59	166.3	211.5	142.9	374	136.4	149.6	126.6	783	122.6	130.7	115.3	112.6	118.2	124.4	122.3	126.6
Alzheimer's disease	52.2	17	41.3	65.5	38.1	96	34.7	41.7	43.7	259	41.4	46.2	47.8	46.0	49.6	45.6	44.3	47.0
Accidents (unintentional injuries)	45.8	14	35.7	58.3	39.1	106	35.8	42.7	35.7	222	33.6	37.9	30.4	29.0	31.9	34.9	33.7	36.0
Cerebrovascular diseases (stroke)	32.7	11	24.5	43.3	34.9	90	31.7	38.3	34.5	209	32.5	36.7	28.8	27.4	30.3	31.6	30.5	32.7
Chronic lower respiratory disease	38.5	10	28.4	51.1	34.9	90	31.7	38.4	27.6	168	25.8	29.6	22.5	21.2	23.8	25.9	24.9	27.0
Diabetes mellitus	33.9	10	25.2	45.2	26.3	70	23.5	29.2	22.0	137	20.4	23.8	14.4	13.4	15.5	18.7	17.8	19.5
Intentional self-harm (suicide)	9.8	3	5.4	16.9	13.1	35	11.2	15.2	11.8	75	10.6	13.1	11.8	10.9	12.7	12.1	11.5	12.8

Table B2[1]
Measures by Area by Zone, Balance of County, and King County

Indicator	Zone A				Zone B				Zone C				Balance of County			King County		
	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Number	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI	Rate	Lower 95% CI	Upper 95% CI
Chronic liver disease and cirrhosis	18.8	6	12.5	27.7	13.1	37	11.2	15.2	10.2	69	9.2	11.4	7.9	7.2	8.6	9.6	9.0	10.2
Influenza and pneumonia	14.3	4	8.8	22.3	13.5	35	11.5	15.7	10.0	61	8.9	11.3	8.6	7.9	9.5	9.9	9.3	10.6
Essential hypertension and hypertensive renal disease	^^	^^	^^	^^	8.7	22	7.1	10.5	6.6	41	5.7	7.6	4.6	4.0	5.2	5.8	5.3	6.2
Nephritis, nephrotic syndrome, and nephrosis	7.0	2	3.4	13.3	9.1	24	7.5	11.0	7.0	42	6.0	8.0	4.1	3.6	4.7	5.7	5.3	6.2
Septicemia	6.7	2	3.2	12.8	7.9	20	6.4	9.6	4.0	24	3.3	4.8	1.2	0.9	1.5	3.0	2.7	3.3
Assault (homicide)	^^	^^	^^	^^	4.0	11	3.0	5.3	3.2	17	2.5	3.9	1.8	1.5	2.2	2.6	2.3	3.0
Certain conditions originating in the perinatal period	^^	^^	^^	^^	8.7	22	7.1	10.5	6.6	41	5.7	7.6	4.6	4.0	5.2	5.8	5.3	6.2
Leading causes of cancer death																		
Lung cancer	36.1	11	26.8	48.0	36.5	96	33.2	40.0	29.9	188	28.0	31.9	27.7	26.3	29.2	29.8	28.7	30.9
Colorectal cancer	10.8	3	5.9	18.4	14.8	40	12.8	17.1	11.0	70	9.8	12.2	11.2	10.4	12.1	11.6	11.0	12.3
Breast cancer (female)	20.5	3	11.5	34.3	20.0	28	16.8	23.7	19.4	68	17.3	21.6	18.1	16.6	19.6	18.8	17.7	20.0
Leading causes of unintentional injury death																		
Poisoning	20.1	6	13.6	29.0	14.8	41	12.8	17.0	12.4	80	11.2	13.7	10.2	9.5	11.1	12.5	11.8	13.1
Falls	8.5	3	4.6	14.9	10.4	27	8.7	12.4	11.1	68	9.9	12.4	11.1	10.2	12.0	11.1	10.5	11.8
Motor Vehicle-Traffic	8.4	3	4.5	15.0	7.1	19	5.7	8.7	5.5	34	4.7	6.5	4.2	3.7	4.8	5.2	4.8	5.7

Table B3
Potentially preventable deaths in airport communities

Cause of Death by Zone	*Observed**			Expected*	Excess*	*SMR*		
	Observed	Lower 95% CI	Upper 95% CI			SMR	Lower 95% CI	Upper 95% CI
Zone A								
Cancer	175	150.0	202.9	126.0	49.0	1.4	1.2	1.6
Diseases of heart	140	117.8	165.2	60.6	79.4	2.3	1.9	2.7
Alzheimer's disease	9	4.1	17.1	7.0	2.0	1.3	0.6	2.5
Accidents (Unintentional injuries)	60	45.8	77.2	33.2	26.8	1.8	1.4	2.3
Cerebrovascular diseases (stroke)	23	14.6	34.5	12.0	11.0	1.9	1.2	2.9
Zone B								
Cancer	1494	1419.2	1571.7	1168.8	325.2	1.3	1.2	1.3
Diseases of heart	907	848.9	968.0	563.5	343.5	1.6	1.5	1.7
Alzheimer's disease	55	41.4	71.6	65.2	-10.2	0.8	0.6	1.1
Accidents (Unintentional injuries)	409	370.3	450.6	291.2	117.8	1.4	1.3	1.5
Cerebrovascular diseases (stroke)	199	172.3	228.7	111.3	87.7	1.8	1.5	2.1
Zone C								
Cancer	3000	2893.6	3109.3	2845.9	154.1	1.1	1.0	1.1
Diseases of heart	1797	1714.9	1882.1	1374.4	422.6	1.3	1.2	1.4
Alzheimer's disease	159	135.2	185.7	160.0	-1.0	1	0.8	1.2
Accidents (Unintentional injuries)	849	792.8	908.1	687.6	161.4	1.2	1.2	1.3
Cerebrovascular diseases (stroke)	381	343.7	421.2	271.4	109.6	1.4	1.3	1.6

*Observed, expected and excess deaths are totaled for the 5-year period so the reader can see how significance method was chosen (see Appendix A for details).

Appendix C. Strength-of-Evidence Analysis Methods and Annotations

Appendix C. Strength-of-Evidence Analysis Methods and Annotations

Strength-of-evidence ratings presented in this report align with the five-level causal framework that the EPA uses in the Integrated Science Assessment (ISA) reports developed to assess air pollutant effects on health.[1] The scale summarizes how strongly the scientific evidence supports the claim that an exposure like noise pollution can cause a given set of health outcomes such as cardiac effects. The outcomes under consideration are grouped into categories such as "cardiovascular outcomes" or "birth outcomes" to help summarize the vast number of outcomes that have been studied. These reflect categories used in the systematic reviews and ISAs reviewed for this report. In the case of air pollution exposures, most of the outcome groups are further separated according to short- or long-term exposures. In the ISA documents the EPA makes explicit causal judgements on the five-level scale for the same groups of outcomes we present in this review. We focused on specific outcomes; associations with mortality more generally can be found in ISA reports. A paraphrased summary of the five levels is provided in Table C1; color classifications correspond to strength-of-evidence pathway trees in Appendix D.

Table C1
Strength-of-Evidence Criteria Applied

Causal	Exposure is shown to lead to effect across multiple high-quality studies by multiple research groups. Plausible alternative explanations for effect have been ruled out. Biological pathways supported by evidence.
Likely Causal	Exposure is shown to lead to effect across multiple high-quality studies, but uncertainties remain. Plausible alternative explanations for effect have been ruled out, but concerns about possible co-pollutant exposures may remain. Biological pathways, while plausible, may be missing evidence.
Suggestive	Exposure seems to lead to effect in at least one high-quality study, but alternative explanations for the effect, such as a third factor, cannot yet be ruled out. May have limited number of studies with modest effects or may have several studies with conflicting results.
Inadequate Evidence	It is unclear if exposure leads to effect or not, because of a lack of quality studies or because of significant inconsistency in results across studies.
Not Likely Causal	Exposure consistently does not appear to lead to effect across studies. Have adequate studies that show no effect across different exposure levels and different populations.

In these criteria, the exposure levels considered are those that would be plausible based on recent monitored levels in community settings. High-quality studies are studies that are peer-reviewed and account for potential causes of bias or flaws in design, measurement, or analysis that could impact results, thus identifying an effect while ruling out possible alternative causes.

A. Noise Pollution Strength-of-Evidence Findings

Annoyance is a pathway because it can amplify the effects of noise pollution on health, as well as a health outcome because annoyance impacts quality of life and mental health. Not everyone will experience annoyance at the same level of noise, but annoyance can add to the body's stress response and increase the disruption that noise causes in daily activities like sleeping, often leading to larger health effects for people who experience more annoyance. Likewise, school performance is discussed as a health outcome because it impacts quality of life, mental health, and lifelong health trajectories for children.

The strength-of-evidence determinations below are based primarily on systematic reviews of scientific studies. Several studies examined aircraft noise specifically, and the strength-of-evidence analysis is based on studies of traffic noise and general environmental noise as well. Support for noise pollution's

relationship to cardiovascular problems and poorer school performance is reviewed in the body of the report. Following are additional details regarding linkages to annoyance, sleep disturbance, birth outcomes, metabolic system, and nervous system concerns.

Noise pollution exposure CAUSES sleep disturbance.[2–4] Studies of self-reported sleep disruption and use of sedative medications confirm that noise pollution disrupts sleep.[4] Numerous studies show an association between chronic sleep disturbance and long-term health concerns, including obesity, diabetes, and hypertension, though more research is needed to understand the specific pathways and mechanisms.[5] Some studies have questioned whether noise-induced disruptions merely replace natural sleep disruptions, leaving the effects of these disturbances on health unclear. In the short term, however, sleep disturbance can impact productivity, stress levels, and immune function.[6] Sleep can also be disrupted by noise pollution in ways that impact quality of sleep without causing waking.[2,6] Sleep disturbances also contribute to annoyance and chronic stress and may impact metabolic functions.[2,7]

Noise pollution exposure CAUSES annoyance.[2,8] Some populations are more likely to experience noise-related annoyance. Annoyance can amplify the stress response caused by noise, leading to stronger effects on health. Annoyance can also be disruptive for mental health and social relationships.

Evidence **SUGGESTS** that long-term noise pollution exposures may have metabolic and neurological effects. Researchers have observed higher rates of diabetes and other metabolic outcomes in communities exposed to higher noise pollution, controlling for other factors,[2,9,10] though evidence is limited to a small number of studies. Researchers hypothesize that the effects of noise pollution on stress response and sleep disturbance can impact metabolic functions and insulin sensitivity.[2,11,12] Similarly, noise pollution may contribute to poorer neurological outcomes because of sleep disturbance and stress response.[2,11,13] Researchers have examined the effects of noise pollution-induced sleep disturbance on child mental and emotional health, hyperactivity, and conduct issues at school.[2,14,15] Other studies have examined adult anxiety and depression symptoms and cognitive scores.[16] However, air pollution has not been adequately controlled for in many studies, and some results have been inconsistent.

Evidence is **INADEQUATE** for long-term noise pollution exposure and concerning birth outcomes. Some studies of occupational noise exposures have shown higher risk for low birth weight and preterm births, but there have been few studies on residential noise pollution exposures and pregnancy outcomes.[17] It is hypothesized that the stress response induced by chronic noise pollution exposures contributes to inflammation and oxidative stress, which can have small effects on fetal growth and potential for earlier delivery.[18,19] A 2019 analysis of several studies found a small effect on birth weight, but did not find evidence of effects on other birth outcomes.[20] Recent analyses of a London birth cohort found a higher risk of preterm birth with noise levels over 65 dB when air pollutants were included in the model, but not independently.[21] More rigorous studies are needed to better understand effects on reproduction and birth outcomes.

B. Air Pollution Strength-of-Evidence Findings

1. Particulate Matter

Particulate matter (PM) from combustion sources is a mixture of tiny solid and liquid particles. Most are less than 1 micrometer in diameter. They contain varying amounts of nitrogen oxides, elemental carbon, and many different hydrocarbons and more complex substances—including formaldehyde, acrolein, polycyclic aromatic hydrocarbons, and similar chemicals, as well as a variety of metals. Particle size influences how the particles move through the air—smaller particles can remain in the air longer and travel farther. Particle size also influences how the particles move through the human body. Particulate matter includes many compounds, and is defined based on the size of the particles:

- $PM_{10–2.5}$ refers to particles with diameters between 2.5 and 10 µm (considered "coarse" particles).
- $PM_{2.5}$ refers to particles with diameters less than 2.5µm (including both ultrafine and fine particles). These particles are small enough to find their way deep into the lungs and move into other systems of the body.
- Ultrafine PM (UFPM) includes only the smallest particles (diameters less than 0.1µm or micrometer). Like $PM_{2.5,}$ UFPM can penetrate cells and thus penetrate bodily systems. These particles are small enough to find their way deep into the lungs and move into other systems of the body.

The strength-of-evidence determinations for coarse, fine, and ultrafine PM are based on the 2019 ISA on Particulate Matter from the EPA, expert review letters that preceded finalization of the 2019 PM ISA,[18,19,22] and systematic reviews and technical reports published since 2010. The following information is from the 2019 PM ISA, unless citations indicate different or additional sources.

2. Coarse Particulate Matter

Evidence **SUGGESTS** that short-term coarse PM exposure may lead to respiratory problems.[23] Days of higher coarse PM exposure are associated with more asthma attacks. Evidence is mixed for exacerbation of COPD symptoms. Coarse PM exposures may increase susceptibility to respiratory infections, and people with underlying respiratory illness may be more likely to experience respiratory death on days following high coarse PM levels.

Evidence **SUGGESTS** that short-term and long-term coarse PM exposure may lead to cardiovascular problems.[18,19,22] Days of higher coarse PM levels may lead to small increases in blood pressure. People with underlying cardiovascular disease may experience worsened symptoms, changes in heartbeat, and increased risk of blood clots or heart attack. Populations may experience higher rates of cardiac-related death in the days following higher coarse PM exposure. Populations exposed to coarse PM over several years may have higher rates of cardiac-related death. Exposure over several years may lead to higher rates of heart disease, stroke, and pulmonary embolism.[24]

Evidence **SUGGESTS** that long-term coarse PM exposure may lead to metabolic and central nervous system problems and cancer.[25] Populations exposed to coarse PM over several years may have higher rates of type 2 diabetes. Exposure over several years may lead to more issues related to higher blood glucose levels and insulin resistance.[26] Populations exposed to coarse PM over longer periods may have higher rates of anxiety or depression[27] and cognitive decline in adults. Some studies have shown increases in lung cancer in regions of higher exposure and two studies have found higher rates of breast and liver cancers in higher-exposure areas. Exposure may alter gene expression in the brain, which can lead to brain tumors, though only a few animal studies have examined this outcome.[27]

Evidence **SUGGESTS** that coarse PM exposure has an impact on birth outcomes. Exposure is associated with preterm birth[27,28] and lower birth weight, but all other explanations have not been ruled out. There is mixed evidence from a small number of studies for effects on preeclampsia and some birth defects. Exposure could contribute to infant death from respiratory causes, but this has been examined in only two studies.

Evidence is **INADEQUATE** for coarse PM exposure and reproduction and fertility effects, and birth outcomes. Exposure could relate to infertility, endometriosis, and reduced birth rates, but only a couple of studies have examined any of these outcomes. Exposure is associated with preterm birth[21,27] and lower birth weight,[18,19] but all other explanations have not been ruled out. There is mixed evidence from

a small number of studies for effects on preeclampsia and some birth defects. Exposure could contribute to infant death from respiratory causes, but this has been examined in only two studies.

Evidence is **INADEQUATE** for long-term coarse PM exposure and respiratory problems. Exposure over several years may lead to poorer lung function, asthma development, and susceptibility to respiratory infections among children. However, other explanations have not been ruled out.

Evidence is **INADEQUATE** for short-term coarse PM exposure and central nervous system effects. Short-term exposure may trigger stress response, leading to higher levels of stress-related chemicals in the brain, though only a single study has examined this outcome.

3. Fine Particulate Matter

Short- and long-term $PM_{2.5}$ exposures CAUSE cardiovascular and cerebrovascular problems. People with heart disease or hypertension are at higher risk of heart attack, stroke, and cardiac-related death following days of higher $PM_{2.5}$ levels.[28] People without underlying heart disease can experience increases in blood pressure and heart rate variability following days of higher $PM_{2.5}$ levels. Populations exposed to even moderate levels of $PM_{2.5}$ over many years develop higher rates of heart disease and hypertension. These populations experience more heart attacks, strokes, and cardiac-related deaths.

Short- and long-term $PM_{2.5}$ exposures CAUSE respiratory problems. While the 2009 and 2019 ISAs conclude that $PM_{2.5}$ *likely causes* respiratory effects, many experts have concluded the evidence is strong that both short- and long-term exposures *cause* respiratory effects.[18,19] During days of higher $PM_{2.5}$ levels, people with asthma are at higher risk of asthma attack. People with COPD and people with allergies are likely to experience worsened symptoms. People with underlying respiratory illness are more likely to experience respiratory death. Populations without underlying respiratory conditions are at increased risk of contracting respiratory infections on days following higher $PM_{2.5}$ levels. Populations exposed to moderate $PM_{2.5}$ over several years are likely to experience more respiratory infections and have higher rates of respiratory-related death.

Long-term $PM_{2.5}$ exposure LIKELY CAUSES cancer and cancer-related death. Populations exposed to moderate $PM_{2.5}$ over several years have higher rates of lung cancer and lung cancer–related deaths. These populations aren't at higher risk of other types of cancer, but they are less likely to survive other types of cancer.

Long-term $PM_{2.5}$ exposure LIKELY CAUSES nervous system problems. Populations exposed to higher levels of $PM_{2.5}$ over several years have higher rates of dementia and cognitive decline among older adults.[29]

Long-term $PM_{2.5}$ exposure LIKELY CAUSES birth outcome concerns. Long-term $PM_{2.5}$ exposure is related to higher rates of preeclampsia and gestational diabetes among pregnant people, lower birth weights and more preterm births,[21,27] and some birth defects, as well as higher occurrences of fetal death and stillbirth, and infant death (death before first birthday).

Evidence **SUGGESTS** that long-term $PM_{2.5}$ exposure may lead to reproduction and fertility problems. Exposure is shown in some studies to result in negative effects on sperm and eggs, changes in ovulation, and erectile dysfunction in the general population, but existing studies are limited, and for effects on sperm one study found no effect. Exposure to higher levels while trying to conceive has resulted in reduced ability to conceive among people undergoing *in vitro* fertilization.

Evidence **SUGGESTS** that short-term $PM_{2.5}$ exposure may lead to nervous system problems. People with Parkinson's disease may experience an aggravation of symptoms due to days of higher $PM_{2.5}$ levels. People may experience higher levels of cortisol related to stress on days following higher $PM_{2.5}$ levels.

Evidence **SUGGESTS** that short- and long-term $PM_{2.5}$ exposure may lead to metabolic problems. Following days of higher $PM_{2.5}$ levels, populations with diabetes and metabolic disease are likely to experience worsened symptoms and require hospitalizations. On these days, populations without underlying diabetes or metabolic disease are likely to have increases in blood sugar and insulin levels. Populations exposed to moderate levels of $PM_{2.5}$ over several years are likely to develop higher rates of metabolic syndrome and type 2 diabetes and suffer higher rates of metabolic- and diabetes-related deaths.

4. Ultrafine Particulate Matter

Evidence SUGGESTS that long-term UFP exposure may result in nervous system problems. Longer periods of exposure to high UFP concentrations likely lead to stress response and inflammation throughout the brain. People exposed to high UFP levels for long periods can experience neurodegeneration and potentially develop Alzheimer's. Long-term exposure to high UFP may impact cognitive abilities and lead to more impulsive behavior.

Evidence **SUGGESTS** that short-term UFP exposure may lead to respiratory problems. Days of higher UFP levels may lead to poorer lung function and worse symptoms among people with asthma. People with asthma may also experience more respiratory infections. People with COPD may experience worse symptoms. People with underlying respiratory disease may be at higher risk of death on days of higher UFP levels.

Evidence **SUGGESTS** that short-term UFP exposure may lead to cardiovascular problems. Strongest evidence: People with underlying heart disease may experience more heart-rate variability and susceptibility to blood clotting in the days following higher UFP exposure. Other evidence: People with underlying heart disease may experience worse symptoms of heart disease and stroke in days following high UFP exposure. General population may experience increases in blood pressure in days following high UFP exposure.

Evidence **SUGGESTS** that short-term UFP exposure may lead to central nervous system problems. Short-term exposures to higher UFP levels can trigger stress response and inflammation in the brain.

Evidence **SUGGESTS** that long-term UFP exposure may lead to adverse birth outcomes. Two recent population-based cohort studies found UFP exposure was related to preterm births.[27,30] A limited number of studies in the U.S. produced mixed results in associating exposure to higher UFP levels with low birth weight and preterm birth.

Evidence is **INADEQUATE** for long-term UFP exposure and effects on reproduction and fertility. Exposure to higher UFP in utero may contribute to higher testosterone, though this has not been shown to affect sperm count or quality. Evidence is limited to two studies.

Evidence is **INADEQUATE** for long-term UFP exposure and respiratory and cardiovascular problems. Exposure to UFP over several years could impact asthma development and respiratory death, but the evidence is limited to just a couple of studies. Similarly, exposure to UFP over several years could impact heart function and lead to plaque in arteries, but evidence linking long-term UFP exposure and cardiovascular problems is limited to just a couple of studies.

Evidence is **INADEQUATE** for long-term UFP exposure and metabolic problems. Short-term exposure to higher UFP may contribute to an increase in blood sugar, but the evidence is limited to a single study. Long-term exposure to higher UFP may contribute to an increase in fasting blood sugar and average blood sugar, but the evidence is limited to a single study.

Exposure to higher, long-term UFP levels has been shown to lead to genotoxicity and oxidative stress, which can lead to cancer, but only one study has examined cancer as an outcome (breast cancer) and no effect was seen.

5. Ozone

The following causal judgements are based on the EPA's 2019 Ozone ISA and accompanying public comments from former independent review panel members,[31] as well as systematic reviews[32] and technical reports published since 2012. The following information is from the 2019 Ozone ISA,[33] unless citations indicate different or additional sources.

Short-term ozone exposure CAUSES respiratory problems. Multiple studies show that short-term exposure can cause decreased lung function in young, healthy adults and lead to increased susceptibility to respiratory infections and respiratory symptoms in the general population. It can also worsen symptoms of asthma, COPD, and allergies, leading to increased hospitalizations as well as death in people with underlying respiratory issues.

Long-term ozone exposure LIKELY CAUSES respiratory problems. Exposure likely leads to development of asthma in children and increases the severity of asthma. It can lead to more susceptibility to respiratory infection, development of allergies, and development of COPD. Some studies link long-term exposure to respiratory-related deaths, but this evidence is inconsistent.

Short-term ozone exposure LIKELY CAUSES metabolic problems. Studies link exposure to higher blood sugar, higher insulin levels, and other metabolic-related changes.

Evidence **SUGGESTS** that short- and long-term ozone exposure may lead to cardiovascular effects and metabolic problems. Some findings show that ozone exposure leads to impaired heart function, heart rate variability, inflammation, or oxidative stress, and diabetes-related deaths, but results across all relevant studies are inconsistent. Some evidence shows an association with long-term exposure and blood pressure, hypertension, and cardiovascular mortality. To date, little evidence shows a link to heart disease, heart attack, heart failure, or stroke.

Evidence **SUGGESTS** that long-term ozone exposure may lead to fertility and reproductive effects, as well as birth outcomes. A limited number of studies show effects on sperm quality, but alternative explanations have not been ruled out. Exposures in first and second trimesters may lead to lower birth weight and preterm birth,[21] but alternative explanations have not been ruled out.

Evidence **SUGGESTS** that short- and long-term ozone exposure may lead to nervous system effects. Short-term exposure appears to increase depressive symptoms, but evidence is still limited. Stronger evidence exists for long-term exposure effects on cognition. Long-term exposure also could affect depression, neurodegenerative disease, and autism spectrum disorder (ASD), but the evidence is still very limited, especially for ASD.

Evidence is **INADEQUATE** for long-term ozone exposure and cancer. Exposure may contribute to DNA damage, which can lead to cancer, but the evidence is still limited to only a few studies. Some evidence exists for connections with lung cancer, but the populations studied were not representative of general population. Evidence does not point to association with other cancers.

6. Carbon Monoxide

The causal judgements below are based primarily on the EPA's 2010 Carbon Monoxide ISA.[34] Systematic reviews and technical reports published since 2010 were also reviewed for changes in the evidence.

Short-term CO exposure LIKELY CAUSES cardiovascular problems, specifically changes in heart rate due to lower oxygen in the blood.[35] For people with underlying heart disease, exposures can worsen symptoms and trigger irregular heartbeat, which increases the risk of cardiac-related death.

Evidence **SUGGESTS** that short-term CO exposure may lead to respiratory effects. Exposure may worsen symptoms of asthma and COPD in affected populations. Exposure may have small impacts on lung function in the general population.

Evidence **SUGGESTS** that short-term CO exposure may lead to nervous system effects. Exposures causing inflammation in the brain may lead to an increase in depression symptoms.

Evidence **SUGGESTS** that long-term CO exposure may lead to nervous system effects, specifically increased risk of Parkinson's disease and dementia.

Evidence **SUGGESTS** that long-term CO exposure may lead to effects on pregnancy and birth outcomes. Exposures may increase risk of low birth weight, preterm birth, stillbirth, heart-related birth defects, and infant mortality. Exposure during early pregnancy may be connected to development of autism spectrum disorder as well as increased risk of gestational diabetes.

Evidence is **INADEQUATE** for long-term CO exposure effects on respiratory and cardiovascular functioning. Only a few studies examined CO's impact on allergy and asthma development and severity, and alternative explanations were not ruled out when some impact on lung functioning was observed. Similarly, only a few studies have examined CO exposure associations with heart attack and strokes.

7. Nitrogen Dioxide

The following causal judgements are based on the EPA's 2016 oxides of nitrogen ISA,[36] unless cited otherwise. The 2016 ISA did not assess evidence for effects on the central nervous system, and metabolic effects were not assessed separately from cardiovascular effects. Causal determinations for effects on the metabolic and central nervous systems are instead based primarily on systematic reviews and technical reports published since 2015.[31,37–39]

Short-term NO_2 exposure CAUSES respiratory problems. Exposure to NO_2 can worsen asthma symptoms and trigger asthma attacks. Exposure may also contribute to respiratory symptoms and susceptibility to respiratory infections in the general population. Exposure may worsen symptoms for those with allergies or COPD. Exposure may increase risk for respiratory-related death for those with underlying respiratory conditions.

Long-term NO_2 exposure LIKELY CAUSES respiratory problems. Exposure likely increases risk of developing asthma.

Evidence **SUGGESTS** that short- and long-term NO_2 exposure may lead to cardiovascular effects.[35] Short-term exposures may worsen underlying heart disease. This can increase risk for heart attacks and cardiac-related death. Longer-term exposures may contribute to development of heart disease, which can increase risk of heart attacks and cardiac-related death.

Evidence **SUGGESTS** that long-term NO_2 exposure may lead to cancer, specifically lung cancer. Other cancers (brain, breast, cervical, prostate, bladder, and leukemia) may also be associated with exposure, but the evidence is very limited.

Evidence **SUGGESTS** that long-term NO_2 exposure may lead to metabolic effects,[40,41] specifically, increased risk of developing insulin resistance and type 2 diabetes.

Evidence **SUGGESTS** that long-term NO_2 exposure may lead to nervous system effects.[31] Exposure during pregnancy may be associated with autism spectrum disorder.[42] Longer-term exposures may be associated with dementia,[43] Parkinson's disease,[44,45] and cognitive decline.

Evidence **SUGGESTS** that long-term NO_2 exposure may affect pregnancy and birth outcomes. Exposure during early pregnancy may slightly increase risk for gestational diabetes.

Evidence is **INADEQUATE** for short-term NO_2 exposure and metabolic effects;[46] the number of studies is extremely limited.

Evidence is **INADEQUATE** for short-term NO_2 exposure and nervous system effects,[47] though a few studies linked short-term exposures to inflammation in the brain causing depression symptoms.[25]

Evidence is **INADEQUATE** for long-term NO_2 exposure and effects on reproduction and fertility. Exposures may impact sperm count and quality through inflammation and oxidative stress, but the evidence is limited and mixed.

8. Sulfur Oxides

The causal judgments for sulfur oxides are primarily based on the 2017 ISA on sulfur oxides from the EPA[48] unless otherwise noted with a citation.

Short-term SO_x exposure CAUSES respiratory problems. The evidence is strongest for asthma exacerbation. Short-term exposures also may cause decreased lung function in people with underlying respiratory conditions. These impacts increase risk for respiratory death among people with respiratory conditions.

Evidence **SUGGESTS** that long-term SO_x exposure may lead to respiratory problems. Exposure may contribute to asthma development and severity of asthma in children. Exposure may also contribute to allergy development, increased susceptibility to respiratory infections, and respiratory-related death.

Evidence is **INADEQUATE** for SO_x exposure and cancer. A few studies point to potential effects on risk of lung cancer and risk of death among people with bladder cancer. Overall, evidence is inconsistent and major uncertainties remain.

Evidence is **INADEQUATE** for short-term SO_x exposure and cardiovascular effects. Exposures could contribute to aggravated heart disease or heart failure, heart attack risk, and cardiac-related death. Some evidence is mixed and major alternative explanations have not been ruled out.

Evidence is **INADEQUATE** for long-term SO_x exposure and cardiovascular effects. Long-term exposures could contribute to risk of heart disease, heart attack, stroke, and cardiac-related death, but evidence has been inconsistent.

Evidence is **INADEQUATE** for SO_x exposure and nervous system effects.[47] Short- and long-term exposures may have contributed to depression symptoms in a few studies, but the evidence is very limited.[25]

Evidence is **INADEQUATE** for SO_x exposure and pregnancy and birth outcomes. There is some evidence that exposure may increase risk of preterm birth, but major uncertainties remain. Exposure may contribute to lower birth weights, gestational diabetes, pregnancy loss/fetal death, birth defects, and infant death, but evidence is inconsistent and alternative explanations have not been ruled out.

Evidence is **INADEQUATE** for SO_x exposure and reproduction and fertility effects. A few studies point to potential effects on sperm quality and reduced conception, but major uncertainties remain.

9. Hazardous Air Pollutants

Hazardous air pollutants (HAPs) include 187 air pollutants that the EPA knows or suspects to have serious health effects such as cancer or birth defects. The EPA regulates HAPs by placing emissions standards on equipment (like vehicle engines) rather than monitoring air quality as is done for criteria air pollutants. The greatest sources of HAPs related to airport activities are idling and taxiing aircraft.[49] Road vehicles, ground support equipment, and stationary equipment like generators and AC units also contribute to airport HAPs. The Airport Cooperative Research Program (ACRP) has concluded that the most important HAPs related to airport activities are:[50]

- formaldehyde;
- acrolein;
- 1,3-butadiene;
- naphthalene;
- benzene;
- acetaldehyde; and
- ethylbenzene.

Several other HAPs and potential HAPs are emitted at airports and can have health effects, but the ACRP list prioritizes HAPs that have the highest emissions and are most likely to lead to serious health effects.[50]

Airports report quantities of volatile organic compound (VOC) emissions because VOCs can react in the air to form ozone. Many VOCs are also HAPs because they can affect human health even if they don't form ozone. Aircraft emissions contain some of the most toxic HAPs—formaldehyde, acrolein, and 1,3-butadiene—compared to other airport-related emission sources.[50] One national study estimated that from 2005 to 2006, before the addition of the third runway, SeaTac aircraft VOC emissions during landing and takeoff made up approximately 0.28% of all VOC emissions in the Seattle-Tacoma region.[51]

The impact of airport HAPs emissions on air quality in nearby neighborhoods remains unclear and seems to vary between airports. A study of O'Hare International Airport in Chicago measured higher formaldehyde and acetaldehyde levels at sites near the airport compared to sites in other areas of the city and came to the same conclusion.[52] The ACRP notes that although HAP concentrations return to background levels very quickly in areas around airports, airport activities still contribute to regional ambient concentrations.[50] A 2008 study in Rhode Island found elevated HAP concentrations in areas nearest T. F. Green Airport.[53]

Table C2 summarizes the health effects of the seven HAPs of most concern related to airport activity. They are ordered by how important ACRP concluded they were in relation to airport activities and community health. The health effects listed in the table are based on reviews by EPA and the Centers for Disease Control and Prevention (CDC), along with other systematic reviews of ambient HAP exposures.[54–66] Much of the evidence is lab studies of exposed animals and some epidemiological studies of effects in workers who were chronically exposed to HAPs in their occupation. Formaldehyde has the largest evidence base, which includes many epidemiological studies of observed effects in humans. We did not find major studies of health effects from HAP exposures for communities near airports to help inform causal judgements.

Table C2 Health Effects of Hazardous Air Pollutants Most Prevalent in Airport Operations				
HAP	EPA Classification	WHO Classification	Cancer Effects	Non-Cancer Effects
Formaldehyde	Probable carcinogen	Known carcinogen	Sinonasal and nasopharyngeal cancers, leukemia, possibly lung cancer	Short-term: respiratory and eye irritation Long-term: possible effects on white blood cell counts
Acrolein	Not classifiable	Not classifiable	No or inadequate information–	Short-term: respiratory and eye irritation
1,3-Butadiene	Known carcinogen	Known carcinogen	Leukemia and lymphatic cancers	Short-term: respiratory and eye irritation Long-term: possible cardiovascular diseases, blood disorders
Naphthalene	Probable carcinogen	Probable carcinogen	Lung and laryngeal cancers	Long-term: possible anemia, liver damage, brain damage, cataracts
Benzene	Known carcinogen	Known carcinogen	Leukemia	Short-term: drowsiness, dizziness, rapid heart rate, headaches, etc. Long-term: blood disorders, reproductive effects, damage to immune system
Acetaldehyde	Probable carcinogen	Known carcinogen	Nasal & laryngeal tumors in animal studies	Short-term: respiratory irritation Long-term: possible developmental effects
Ethylbenzene	Not classifiable	Possible carcinogen	No or inadequate information	Short-term: respiratory and eye irritation, dizziness at higher doses Long-term: possible hearing and kidney effects

The EPA and WHO classifications are based on each agency's confidence that the pollutant causes cancer based on the scientific evidence.[58] In a few cases, the WHO has made a stronger classification than the EPA. Formaldehyde dominates the cancer risks of HAPs.[67] Over half of cancer cases nationwide that are attributed to outdoor HAP exposure are attributed to chronic formaldehyde exposure.[68] Acetaldehyde, benzene, naphthalene, and 1,3-butadiene are also significant carcinogens.

There is little to no evidence that acrolein and ethylbenzene cause cancer, but they are included in the list of HAPs of most concern because they are toxic even in low concentrations. This is especially true for acrolein, which dominates the non-cancer risks of HAPs.[67,68] Short-term exposures to several HAPs cause severe respiratory irritation.[57,59,69]

- **Long-term formaldehyde exposure can CAUSE cancer.** When chronically inhaled, formaldehyde can cause inflammation, oxidative stress, and genotoxicity leading to cancer. For formaldehyde these cancers are especially concentrated in the nose and throat, but there is also evidence for leukemia and possibly lung cancer as well. While the EPA has listed formaldehyde as a possible carcinogen, the National Academy of Science has agreed with the WHO and formally concluded that inhaled formaldehyde is a known carcinogen.[69]

- **Short-term formaldehyde exposure CAUSES respiratory and eye irritation.** Formaldehyde may also lead to asthma exacerbation, though evidence is mixed.
- Evidence **SUGGESTS** that long-term formaldehyde exposure has diverse effects in blood. These include changes in white blood cell counts and other immune response–related effects. The evidence for an association is strong, but a wide range of effects have been observed and some studies have found opposing results.[69]

Acrolein:[55,70]

- Evidence is **INADEQUATE** to link acrolein exposure and cancer.
- **Short-term acrolein exposure CAUSES respiratory and eye irritation.** As a highly reactive compound, acrolein has intensely irritating effects, even at low concentrations. Generally, people with underlying respiratory conditions may experience more severe respiratory symptoms from irritating exposures like acrolein, but there are few human studies to confirm this specifically for acrolein.[71]

1,3-Butadiene:[60,72]

- **Long-term 1,3-butadiene exposure can CAUSE cancer.** When chronically inhaled, 1,3-butadiene can cause inflammation, oxidative stress, and genotoxicity leading to cancer. Unlike several other HAPs, 1,3-butadiene has more systemic effects in the body, rather than local effects focused on the nose and throat where inhalation occurs. 1,3-butadiene is linked to leukemia and lymphatic cancers.
- **Short-term 1,3-butadiene exposure CAUSES respiratory and eye irritation.**
- Evidence **SUGGESTS** that long-term 1,3-butadiene exposure may increase risk of cardiovascular disease and blood disorders. This is likely related to inflammation from chronic exposure and resulting oxidative stress.

Naphthalene:[61]

- **Long-term naphthalene exposure is a LIKELY CAUSE of cancer.** Naphthalene exposure is linked to laryngeal cancer (occurring in the larynx, or upper part of the throat) and lung cancer.
- Evidence **SUGGESTS** that long-term naphthalene exposure may be linked to several serious non-cancer effects. Long-term naphthalene exposure has been observed to cause several serious effects in animals (including anemia, cataracts, neurological damage, and liver damage), but these effects have not been confirmed in humans.

Benzene:[64,65]

- **Long-term benzene exposure can CAUSE cancer.** Benzene passes from the lungs to the bloodstream when inhaled. It can sometimes be stored in bone marrow and disrupt blood production and immune response, potentially leading to leukemia over time.
- **Short-term benzene exposure CAUSES drowsiness, dizziness, rapid heart rate, headaches, and similar symptoms.**
- Evidence **SUGGESTS** that long-term benzene exposure is linked to blood disorders like anemia, damage to the immune system, and effects on menstruation and birth outcomes. These effects were observed in animal lab studies and some effects were observed in occupational studies.

Acetaldehyde:[56]

- **Long-term acetaldehyde exposure can CAUSE cancer.** The WHO and EPA differ on whether acetaldehyde causes or probably causes cancer. Animal lab studies observed nasal and laryngeal tumors from acetaldehyde exposures. Studies in humans have been very limited.
- **Short-term acetaldehyde exposure CAUSES respiratory and eye irritation.**
- Evidence is **INADEQUATE** to link long-term exposures and developmental effects. Acetaldehyde exposure was linked to serious developmental effects in a lab animal study, but the exposure route was injection rather than inhalation.

Ethylbenzene:[63,66]

- Evidence **SUGGESTS** that long-term ethylbenzene exposure may be linked to cancer. Evidence has been strong in animal studies, but a single occupational study in humans did not observe any effects.
- **Short-term ethylbenzene exposure CAUSES respiratory and eye irritation and—at higher doses—dizziness.**
- Evidence from animal exposure studies **SUGGESTS** that long-term ethylbenzene exposure (even at lower concentrations) may be linked to damage to the inner ear and kidneys. These effects have not been confirmed in humans.

While the potential health effects of HAPs shown above are serious, the scale of airport emissions and related residential exposure are important for understanding the risk posed by airport-related HAPs. A 2008 FAA-sponsored study found that deaths from airport-related $PM_{2.5}$ were 100 to 200 times larger than the cancer impacts from HAPs.[49,73] These estimates don't include non-cancer effects of HAPs, but the non-cancer effects also do not approach the magnitude of effects from $PM_{2.5}$.

10. Lead

Lead (Pb) is both a HAP and a criteria air pollutant. Inhaled lead is absorbed from the lungs into the bloodstream, where it strongly inhibits nutrient absorption and is highly toxic for cell function in organ systems throughout the body, especially the brain. Lead also gets stored in the blood, bones, and tissues, where it can be released later, re-exposing the body many years after exposure.

Because lead is now removed from gasoline, lead emissions from automobiles are no longer a concern. Commercial jets run on lead-free, kerosene-based fuels, but many small piston-engine planes still use leaded fuel. Piston-engine aircrafts are the largest source of lead emissions in the U.S.[74] Airborne lead concentrations have been found higher than EPA standards over a half mile downwind of general aviation airports.[49] The causal judgments for lead described here and in the report are based primarily on the EPA's 2013 lead ISA.[74] Lead emissions from commercial airports are a few orders of magnitude smaller than other emissions and health effects are reviewed in the main report.

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Appendix D. Strength-of-Evidence Pathway Trees for Noise Pollution and Air Pollutants Common to Airport Operations

Figure D1. Noise Pollution Strength-of-Evidence Pathway Tree

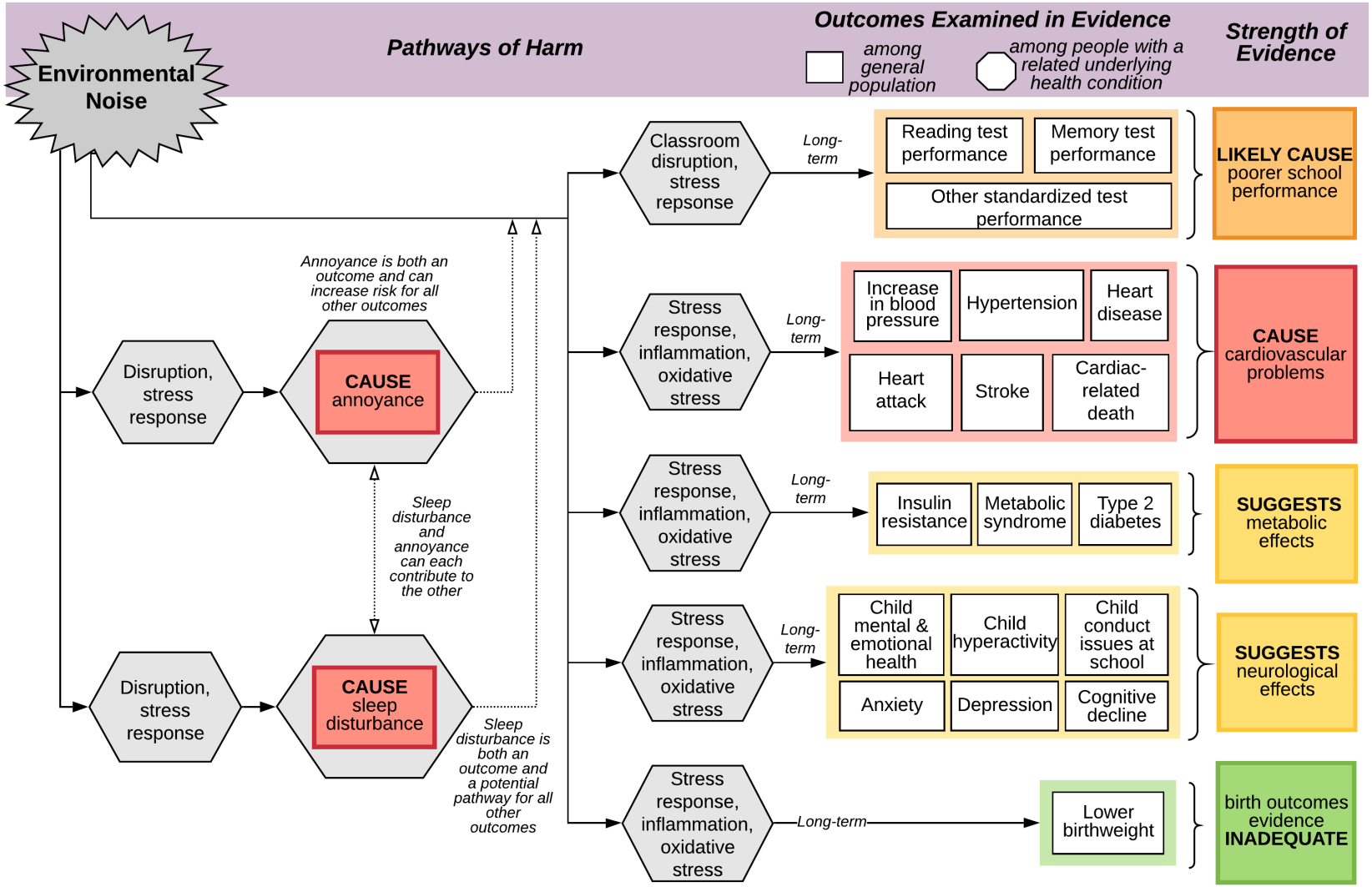


Figure D2. Coarse Particulate Matter Strength-of-Evidence Pathway Tree

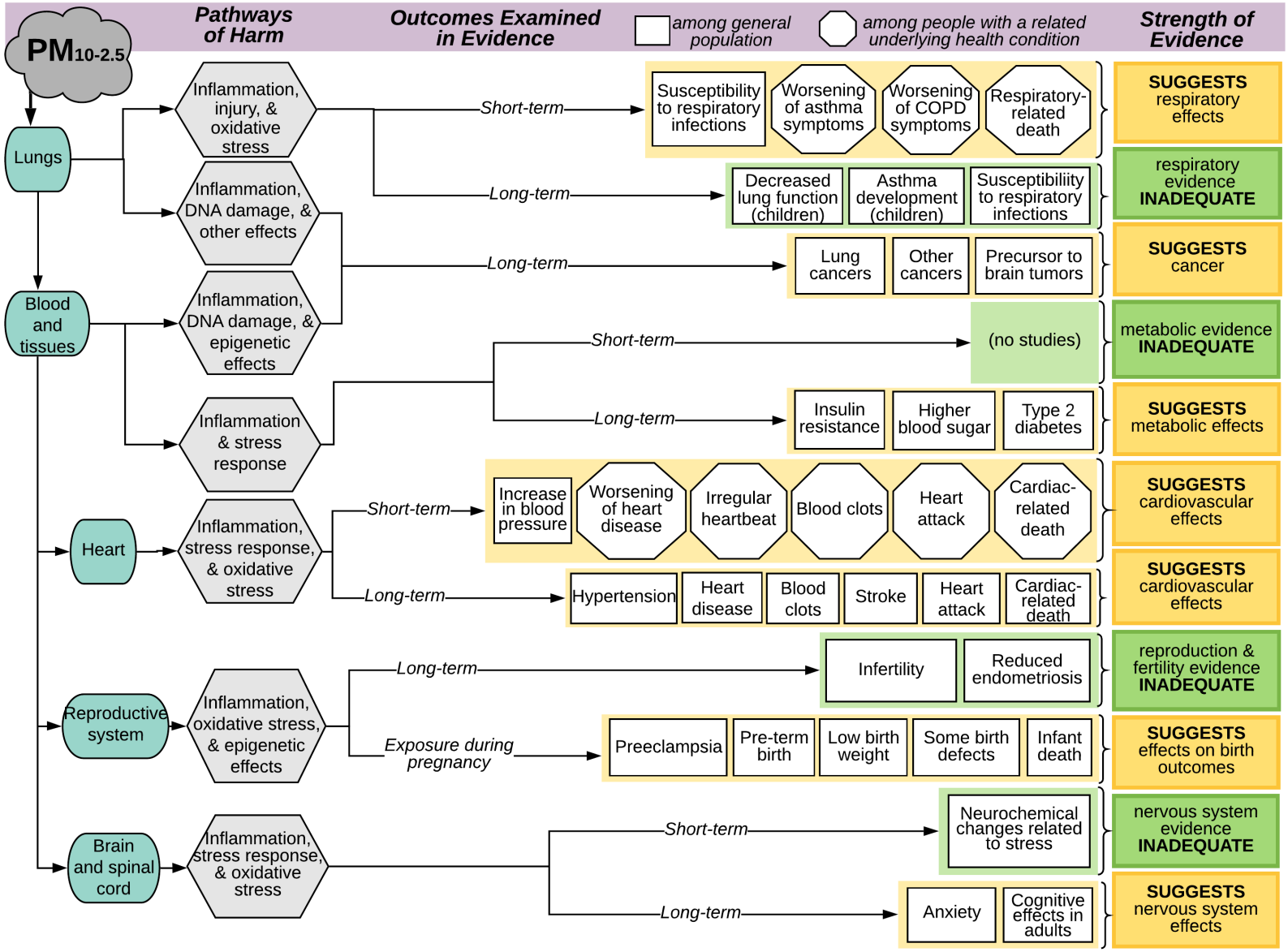


Figure D3. Fine Particulate Matter Strength-of-Evidence Pathway Tree

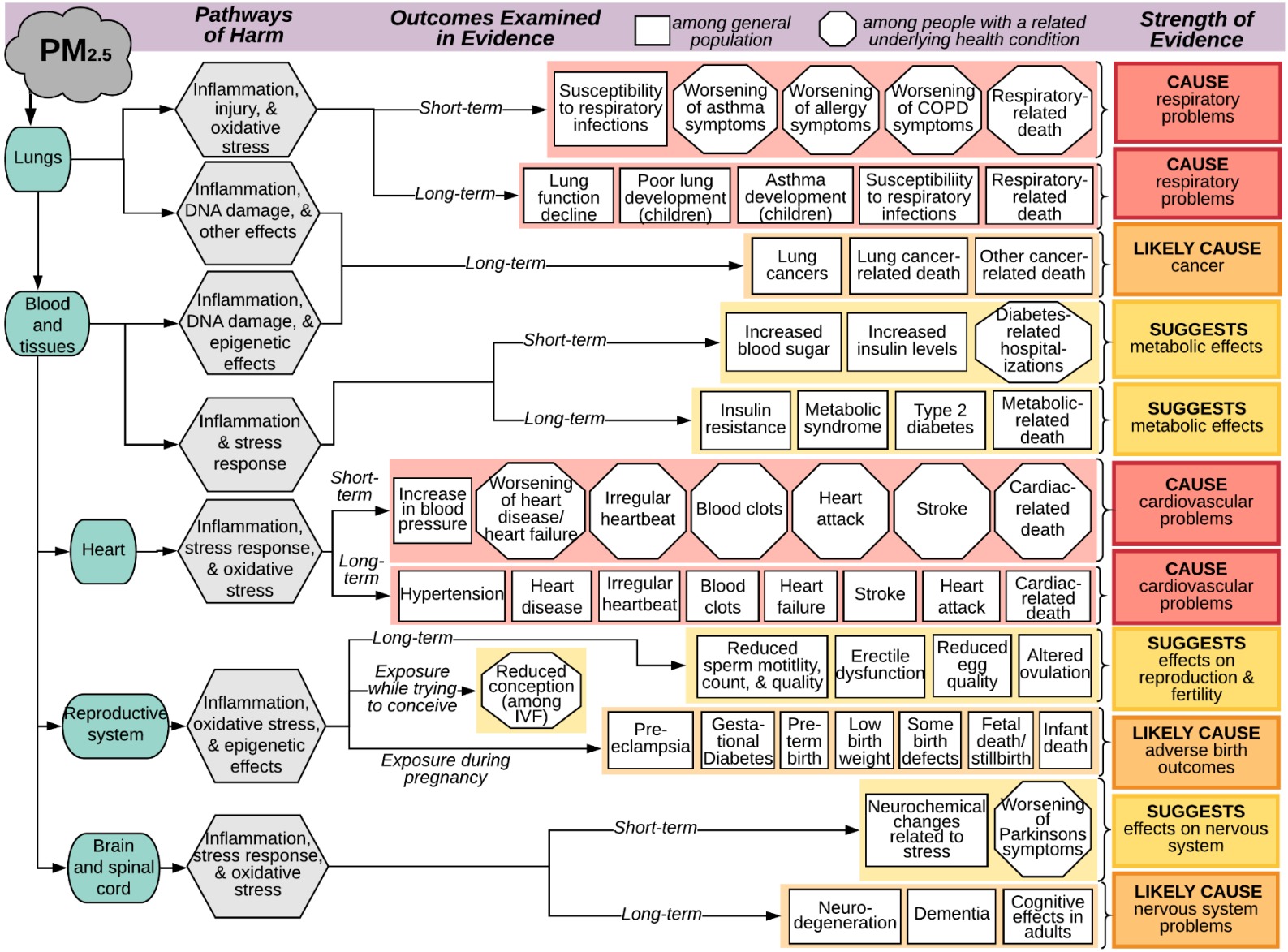


Figure D4. Ultrafine Particulate Matter Strength-of-Evidence Pathway Tree

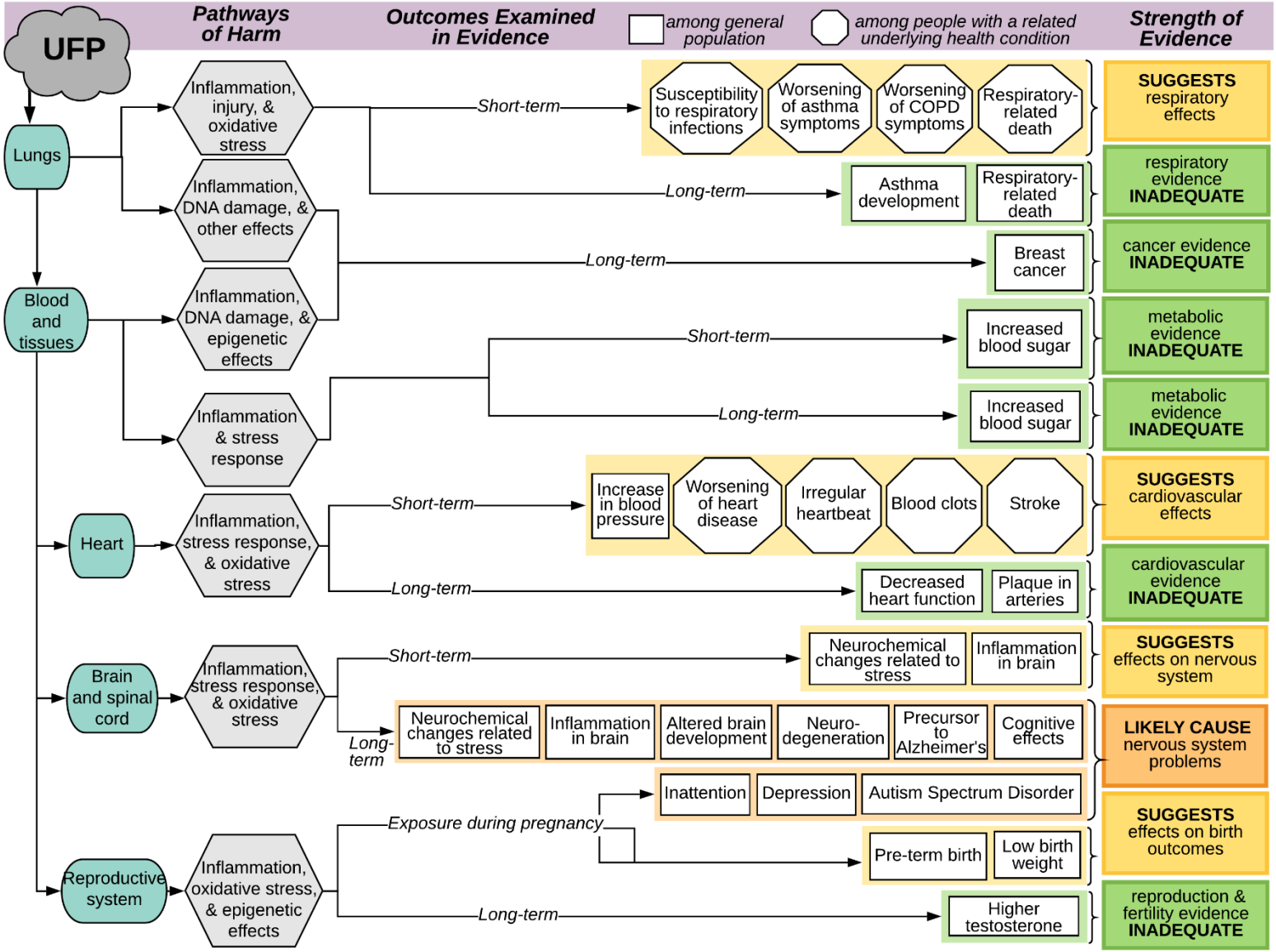


Figure D5. Ozone Strength-of-Evidence Pathway Tree

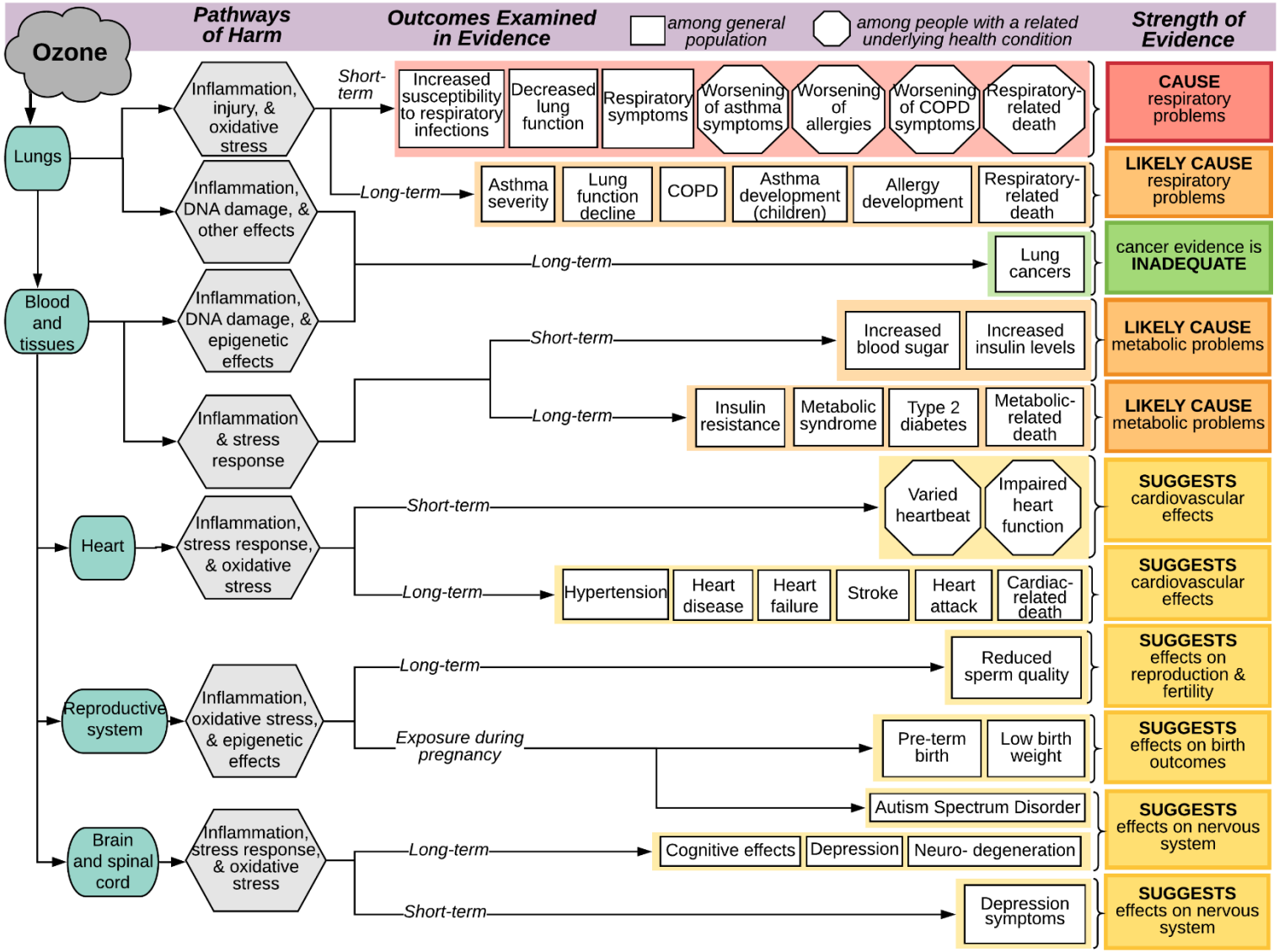


Figure D6. Carbon Monoxide Strength-of-Evidence Pathway Tree

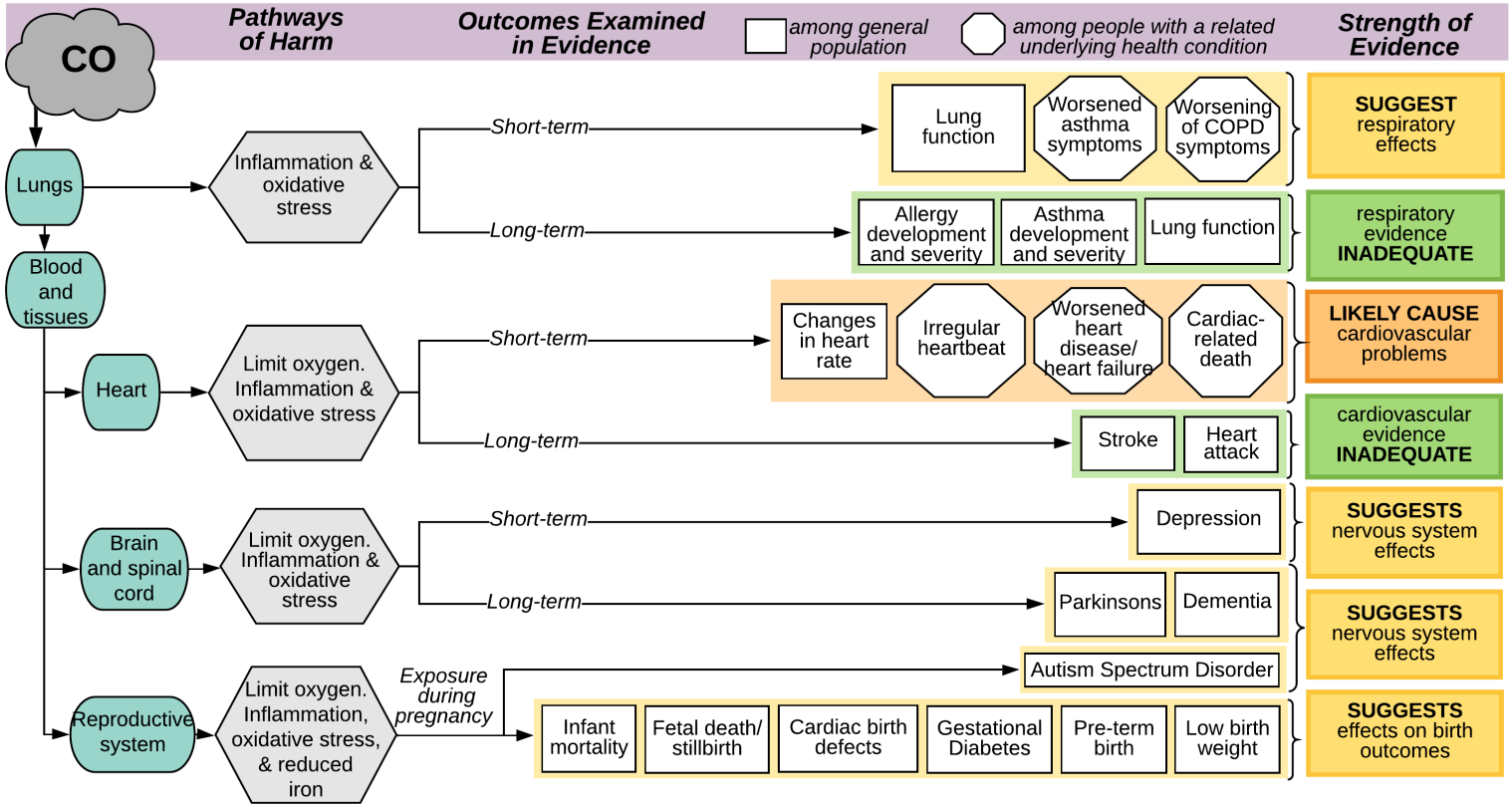


Figure D7. Nitrogen Dioxide Strength-of-Evidence Pathway Tree

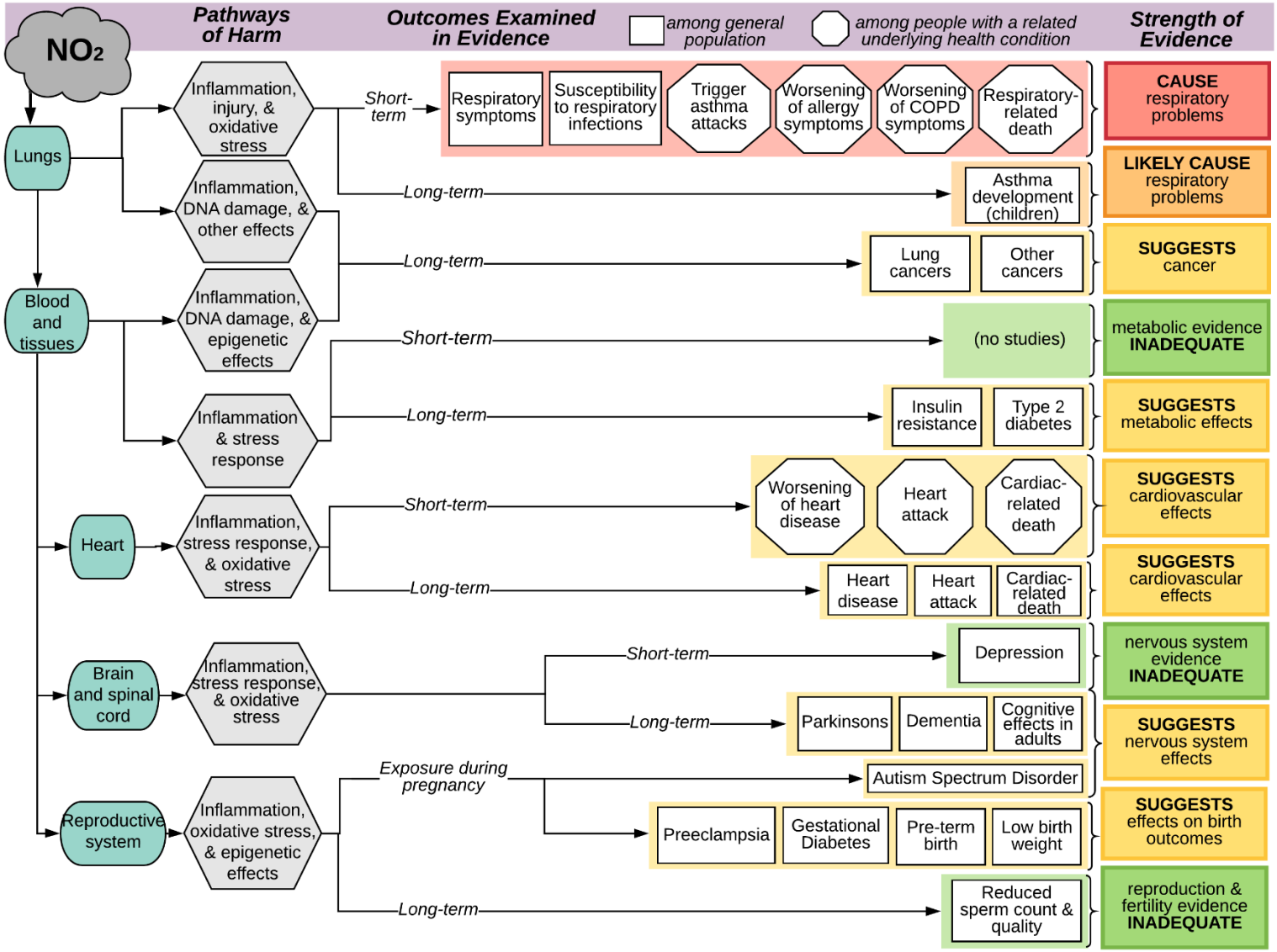
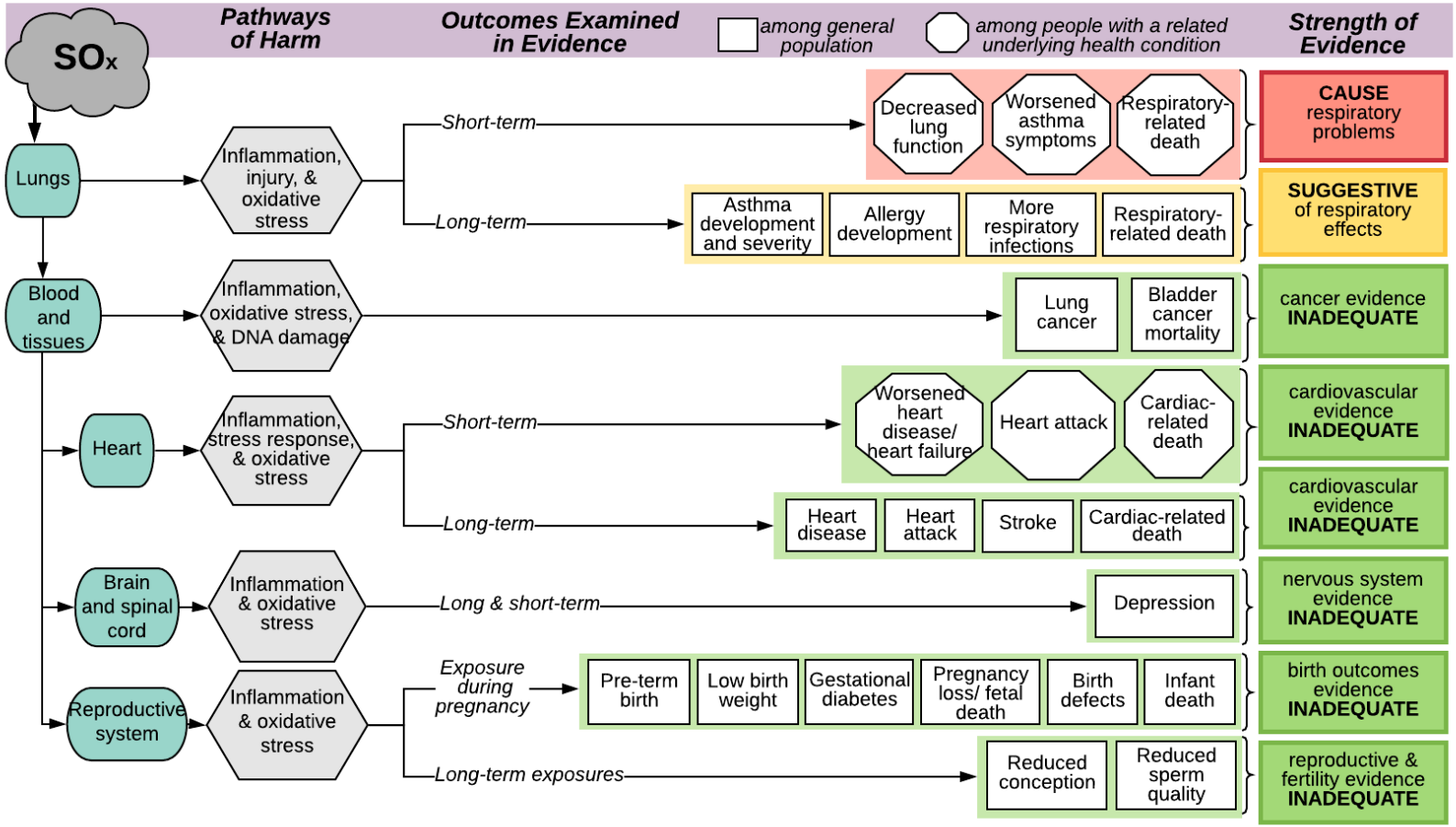


Figure D8. Sulfur Oxide Strength-of-Evidence Pathway Tree



Post-Report Update from the Technical Advisory Committee

Background

The Department of Commerce (Commerce) formed a Technical Advisory Committee (TAC) to help guide the development of the report. The TAC initially consisted of representatives from the six cities within the study area (Sea Tac, Tukwila, Burien, Normandy Park, Federal Way, and Des Moines) and later expanded to include a public representative from each of those cities. The group met with Commerce 25 times during the development of the report and was responsible for the following:

- Assisting in completion of the project charter,
- Assisting in the development of the draft statement of work, review draft request for proposals (RFP)
- Providing review and comments on the draft study.

Stantec Consulting Inc. developed the report. The report identified 72 recommendations to improve impacts of operating the Sea-Tac airport on neighboring cities. The TAC members met virtually after the report's publication to identify priority next steps from among the report's 72 recommendations and to surface any additional concerns.

TAC Post-Report Update

Priority Next Steps

The TAC reviewed the Study's 72 recommendations and prioritized 13 specific items as next steps. These recommendations are not in any priority order.

Public Health

#4. Approve/reauthorize bills to address mitigation packages that have failed or are inadequate.
#9. Expand the late night noise limitation program to reduce effects on neighborhoods.
#8. Require alternative fuel use for airport.

Air Quality
#1. Improve the current monitoring network by increasing the number and location of monitors in and around the airport.

#4. Continue research on the connection of ultrafine particles and health effects.

#5. Conduct a study and improve the monitoring network to determine the extent of regional air pollution effects that are directly related to airport activity.

Noise and Vibration
#1. Develop a set of alternative noise metrics that do not rely on day-night average noise level (DNL) contours.
#4. Institute noise abatement procedures for late-night operations

#5 Expand noise monitor locations (ensure they are working properly) to include study area permanent and mobile monitors.

Mobility
#5. Conduct an airport mobility modes survey to assess how passengers and employees travel to and from the airport.

#8. Develop an airport parking master plan in collaboration with airport vendors and employees, surrounding cities, King County Metro, and Sound Transit.

#19. Identify and eliminate pedestrian mobility barriers.

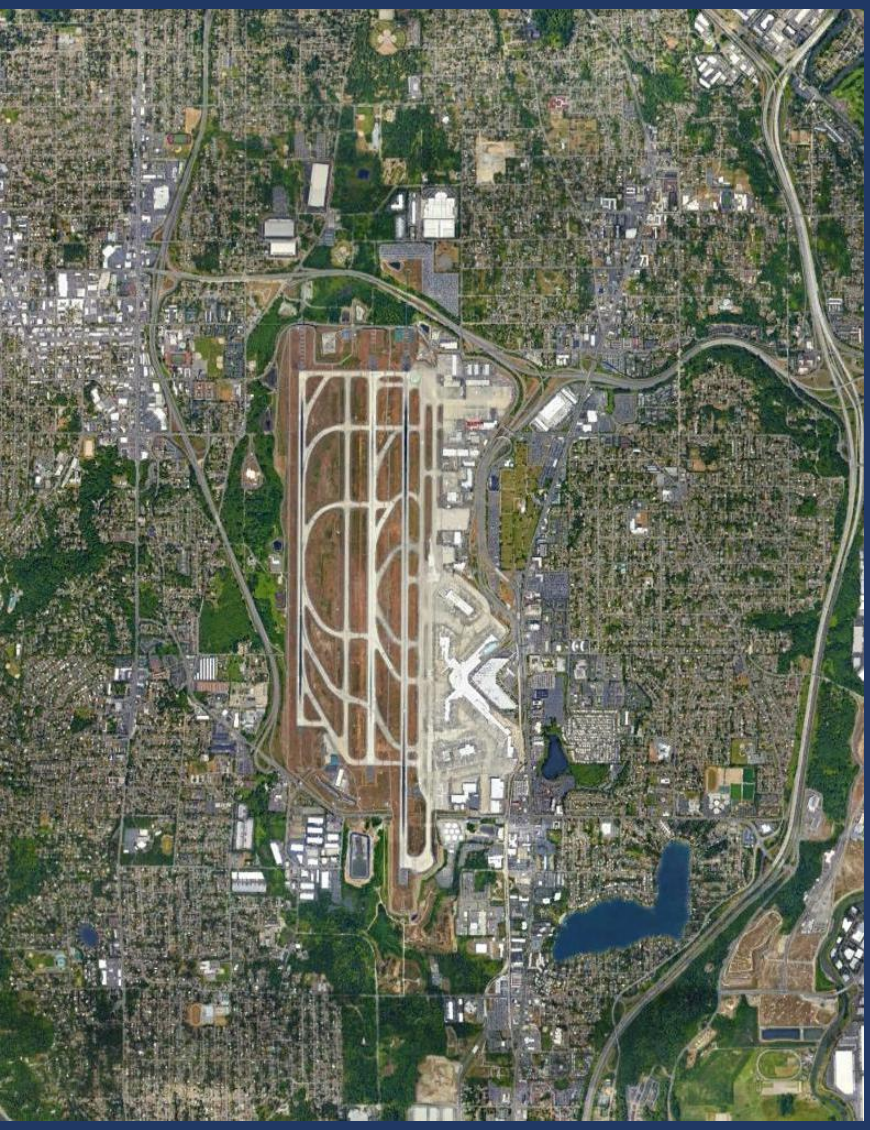
Surface Water/Groundwater/Soils
#4. Conduct independent testing of "black soot" to determine its chemical composition and potential source(s).

Port of Seattle expansion plans

The report identified the Port's plans to expand on page 36, paragraph 3 (see below). A majority of TAC members did not agree with the report's characterization of these expansion plans because the expansion proposal was still under review by the Federal Aviation Administration (FAA) and Port of Seattle.

The TAC recommended page 36, paragraph 3, of the report should read as follows:

The Port of Seattle is also considering expanding airport facilities by an additional 19 gates to address increasing passenger demand. But in November 2019, Alaska Airlines – one of the primary carriers at Seattle-Tacoma International Airport – voiced its opposition to this expansion effort, citing issues with security clearance, passenger convenience, and increased congestion. Alaska Airlines contended that Seattle-Tacoma International Airport "is not on land big enough to sustain the expansion for a major airport" and cited Dallas/Fort Worth International Airport and Denver International Airport as examples. ~~Seattle-Tacoma International Airport's expansion appears to be moving forward in spite of this opposition.~~



Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

prepared by:

Stantec

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Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

May 29, 2020

Prepared for the

Washington State Department of Commerce

as authorized by ESSB 6032

Washington State Department of Commerce

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ACKNOWLEDGMENT

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App F: Other Reports https://deptofcommerce.box.com/s/i1s5cl2hdbblbthh3g3ghj4jlr6nm8dl

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Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Executive summary

Background

The Washington State Legislature asked the Department of Commerce in March 2018 to implement the provisions of (Proviso) Section 127(63) of Engrossed Substitute Senate Bill (ESSB 6032) using the following language:

"(63) (a) $300,000 of the general fund—state appropriation for fiscal year 2019 and $300,000 of the general fund—local appropriation are provided solely for the department to contract with a consultant to study the current and ongoing impacts of the Seattle-Tacoma international airport. The general fund—state funding provided in this subsection serves as a state match and may not be spent unless $300,000 of local matching funds is transferred to the department.

(b) The final study scope shall be developed by the department, in consultation with organizations or entities including members of the legislature, the port of Seattle, and the cities listed in subsection (c)(i),

(c) The study scope must include, but not be limited to:

(i) The impacts that the current and ongoing airport operations have air traffic noise, public health, traffic, congestion, and parking in residential areas, effects on residential and nonresidential property values, and economic development opportunities, in the cities of SeaTac, Burien, Des Moines, Tukwila, Federal Way, Normandy Park;

(ii) The benefits to the same cities referenced in (c)(i) derived due to proximity to the airport, including wages and taxes from airport-related operations, property tax derived from commercial development directly tied to airport-related operations, and improved access to transit resulting from proximity to the airport; and

(iii) Options and recommendations for mitigating any negative impacts, or bolstering potential benefits identified through the analysis, including what role the state plays in addressing impacts and benefits.

(iv) The department must collect data and relevant information from various sources including the port of Seattle, listed cities and communities, regional planning agencies, and other studies.

(v) The study must be delivered to the legislature by December 1, 2019."

The legislature since revised the delivery date of the study from Dec. 1, 2019 to June 1, 2020 via Engrossed House Bill (ESHB) 119 Section 129.

This study (the "2020 Study") acknowledges the importance of Seattle-Tacoma International Airport, not only to the Seattle region but to the state of Washington and should not be construed as "anti-airport" in any fashion.

The 2020 study was based on an objective and independent review and evaluation of existing data to assess the effects that airport operations have on the six cities referenced above – Burien, Des Moines, Federal Way, Normandy Park, the city of SeaTac, and Tukwila – an area that includes over 237,000 residents and covers over 61 square miles. The consultants gathered information from over 400 technical references and met with over 200 people while investigating eight general areas over a 22-year period (1997 through 2019), including:

- Air quality
- Noise
- Environmental effects
- Mobility
- Light
- Public safety
- Public health
- Socio-economics

For each city in the study area, the consultants researched over 65 data points between 1997 and 2019 – over 8,500 data points total (2009 served as a mid-point year). Anecdotal information from study area residents and business owners was also considered.

General findings

Seattle-Tacoma International Airport has grown faster than its surrounding area. Since the 2000 Census, the study area, King County, and the Seattle metropolitan area have grown between 22.8% and 29.4%, while the number of passengers at the airport grew by over 75%, and the number of air carrier operations grew by almost 81%.

The study area cities experience effects to varying degrees. The main negative effect was from **noise**, with additional concerns about **air quality**. There were also some positive effects – **economic benefits** from the airport, as well as its **convenience** and **accessibility**. There are some data gaps where information was not available or was inconsistent, including air quality, public health, and other socio-economic metrics.

The National Plan of Integrated Airport Systems (NPIAS – a report to Congress every two years that supports funding of the U.S. airport system) states on its first page eight guiding principles for airport development. The fifth guiding principle included in the NPIAS states:

> **"Airports should be compatible with surrounding communities, maintaining a balance between the needs of aviation, the environment, and the requirements of residents."**

General recommendations of the 2020 study include:

#1. Establish a single source data clearinghouse for effect metrics and data.
#2. Expand the study area to incorporate areas to the north so that the airport is located in the center of the study area.
#3. Expand participation by the Port of Seattle in any follow-up studies.
#4. Improve the airport/community relationship.
#5. Develop a plan for airport-adjacent perimeter areas.
#6. Follow NPIAS attribute #5 regarding surrounding communities.
#7. Conduct an expanded Phase 2 study.

Effects from noise and vibration

Noise was the primary negative effect, especially in Burien, Des Moines, Normandy Park, Federal Way, and in parts of the city of SeaTac. This was due to the implementation of the NextGen procedures that concentrate flight tracks into a narrower area, as well as the airport's rapid growth. Noise concerns

include sleep disturbance, learning disruption, lower property values, and other concerns. Recommendations of the 2020 study include:

#1. Develop a set of alternative noise metrics that do not rely on day-night average noise level (DNL) contours.
#2. Increase the arrival glideslope to a minimum of 3 degrees.
#3. Conduct an environmental review for flight track changes.
#4. Institute noise abatement procedures for late-night operations
#5. Expand noise monitor locations to include study area permanent and mobile monitors.
#6. Address existing mitigation packages to fix faulty installations.
#7. Revise the Port Commission makeup to include direct representation from the study area.
#8. Conduct additional vibrational monitoring in the study area.
#9. Determine the effects associated with sound exposure levels (SELs).
#10. Determine the effectiveness of sound insulation practices, especially those used by the Port of Seattle in its mitigation packages.

Effects on air quality

Contributors to regional air quality include stationary sources (such as manufacturing), mobile sources (cars and trucks), as well as the airport. While the Seattle area is technically in compliance with EPA standards, that statement can be misleading because of the inadequate network of air quality monitors, most of which are not located close to the airport. There are other concerns that require additional research including ultra-fine particulates (UFPs), reports by study area residents of a black residue, and other concerns. There are also gaps in the air quality data, some of which may be outdated, that warrant additional study. Recommendations of the 2020 study include:

#1. Improve the current monitoring network by increasing the number and location of monitors in and around the airport.
#2. Establish monitoring guidelines for new locations that consider economics, security, logistics, and atmospheric and pollution considerations.
#3. Deploy PurpleAir monitors to get a general sample of air quality trends.
#4. Research the connection of ultrafine particles and health effects.
#5. Conduct a study and improve the monitoring network to determine the extent of regional air pollution effects that are directly related to airport activity. (Seattle-King County Health District is studying regional impacts related to air quality. Their findings were not completed in time to inform this study.)

Regional impacts associated with the airport air pollution emissions are likely not fully reflected by the current air quality monitoring network because of geographic distribution of the monitors.

Effects on mobility

Mobility includes cars, buses, light rail, bicycles, and pedestrians (Seattle-Tacoma International Airport is one of the few U.S. airports to which people can walk). As with many urban areas, traffic has been an increasing problem in the Seattle region, partially because roadway network improvements have favored transit improvements over increasing roadway capacity. While congestion has increased at several intersections around the airport, weekday peak-period congestion is also a problem across the region.

The airport is especially busy during holiday periods like Thanksgiving and Christmas. What is not clear is whether ridesharing services may be increasing pick-up/drop- off traffic.

Parking at the airport warrants additional study, since there were concerns of employees using park & ride lots and garages instead of the dedicated airport employee Lots. And while the main parking garage has increased its capacity, there was no data on where users are coming from. Recommendations of the 2020 study (many of which are for additional study) include:

#1. Generate rental car forecasts for annual service demand.
#2. Conduct an annual parking demand study for the main parking garage and employee parking lots.
#3. Conduct an annual cell phone lot demand study to determine if the cell phone lot reduces congestion at the arrivals and departures areas in front of the terminal.
#4. Inventory private parking lot data to determine the effect on the main parking garage.
#5. Conduct an airport mobility modes survey to assess how passengers and employees travel to and from the airport.
#6. Conduct a drop-off/pick-up zone study to assess congestion and vehicle and pedestrian flow in and around the airport property.
#7. Forecast employee/vendor/tenant demand to ensure there are parking and mobility options to accommodate changing employment.
#8. Develop an airport parking master plan in collaboration with airport vendors and employees, surrounding cities, King County Metro, and Sound Transit.
#9. Develop a transportation improvement program database of all historical and current capital improvements in the Seattle-Tacoma International Airport area to demonstrate network changes over time.
#10. Conduct a rental car origin-destination study to understand vehicle patterns and movements along the transportation network around the facility as well as understand where vehicles are traveling from to reach the facility.
#11. Develop a targeted annual traffic monitoring system to create a consistent and reliable database that monitors congestion over time.
#12. Conduct an annual transit demand analysis to document transit demand in the study area and ways to improve transit ridership to the airport.
#13. Improve use of transit by airport passengers and employees.
#14. Analyze park & ride use to determine how many individuals use the facilities to access the airport.
#15. Conduct a park & ride license plate analysis to determine where vehicles originate and to better understand park & ride demand patterns.
#16. Conduct an off-street parking license plate analysis to understand where vehicles originate from in the study area and the use of certain on-and off-street facilities.
#17. Conduct a transit origin/destination Study to analyze travel patterns and average daily traffic in the study area.
#18. Conduct an annual pedestrian count to determine the number of individuals that use the sidewalk along the front of the terminal and the Link Light Rail Airport/SeaTac station pedestrian bridge to access the airport.
#19. Identify and eliminate pedestrian mobility barriers.
#20. Conduct an ongoing on-street parking study in Burien, Tukwila, and SeaTac to monitor supply, use, duration, and areas with excessively high use from non-residents.
#21. Establish an existing/baseline conditions for specific off-and on-street parking facilities in Burien, SeaTac, and Tukwila.
#22. Establish and maintain a parking supply database to provide insight on parking demand in the area, and give local communities an inventory that can be expanded and monitored over time.

#23. Adopt or expand parking permit programs in Burien and Tukwila to discourage long-term airport passenger and employee parking on residential streets.
#24. Create an informational program to educate airport employees and passengers regarding local parking restrictions.
#25. The Port of Seattle should adopt a formal policy that prohibits airport employees from using on-street off-airport parking during working hours.

Effects on surface water, groundwater and soil

The airport has taken positive steps to protect area streams, floodplains, and wetlands. More monitoring and testing are recommended to ensure the long-term protection of these sensitive environmental assets. There are some concerns regarding leakages from underground storage tanks – both off and on the airport. Study area residents reported a black residue on surfaces (ground, structures, etc.). Recommendations of the 2020 study include:

#1. Correct potential errors and data gaps to create a more consistent data record.
#2. Improve receiving stream data through more permanent monitoring stations downstream and a suite of water quality parameters that are collected at outfalls regularly to make results more consistent and comparable.
#3. Further study air pollution effects on surface water through independent analyses of citizen-reported pollution samples on surface water locations.
#4. Conduct independent testing of "black soot" to determine its chemical composition and potential source(s).
#5. Conduct ongoing monitoring and sampling of AOMA groundwater monitoring wells on a three-year cycle for key indicator parameters.
#6. Coordinate with study area comprehensive plans to ensure the ongoing health and preservation of groundwater and soil areas throughout the study area.

Effects from light

Light intrusion was not found to be a concern in the study area. The airport is upgrading metal halide lighting with energy efficient LED fixtures, which also addresses glare. Recommendations of the 2020 study include:

#1. Update airport high mast lighting and replace with LED sources.
#2. Adopt study area lighting Standards that would establish guidelines for future developments and renovations of existing facilities.

Effects on public safety

Public safety varies by city in the study area, and there are no known links to the airport. Crime has stabilized and, in some cases, decreased in the study area, including motor vehicle thefts, violent crimes, and property crimes. Normandy Park has the lowest incidence of most crimes, but Tukwila reported the highest rate of most reported crimes, which may be due to the concentration of retail destinations (such as Southcenter Mall). However, it could not be determined if these negative effects were attributable to proximity to Seattle-Tacoma International Airport.

Human trafficking and illegal drug trafficking are global problems, the former often associated with large metropolitan areas with international airports. It was not possible to track any effects in the study area due to the absence of data at the municipal level. Hotel rooms in the study area are concentrated in the

cities of SeaTac and Tukwila, but that does not prove a direct link to human trafficking or illegal drug trafficking. The legalization of recreational and medical marijuana use has also altered drug enforcement in many communities, not only locally but nationwide. Recommendations of the 2020 study include:

#1. Modify the second level study to include areas to the north of Seattle-Tacoma International Airport.

#2. Consider an airport overlay district to address crime on a multi-city level.

#3. Pursue multiple approaches to assist victims of sex trafficking.

#4. Consider Crime Prevention Through Environmental Design (CPTED) principles in portions of the study area.

Effects on public health

Public health metrics vary within the study area and there was no data that indicated a link to the airport. Multiple factors contribute to public health including income level, poor health habits, genetic predispositions, and other diverse sources. Further research and analysis are recommended.

Public health outcomes noted include decreases in the accident rate and some declines in the rates of cancer and heart disease in the study area cities and King County between 2012 and 2016. Life expectancy in the study area cities is almost equal to the average for the state of Washington and the U.S. and is only slightly below the King County average. However, it could not be determined if these were due to national trends, attributable to proximity to Seattle-Tacoma International Airport or other contributing factors.

The method that public health statistics were available prevented a local-level analysis for four of the six study area cities (Des Moines/Normandy Park and SeaTac/Tukwila), making local level comparisons impossible. Additional studies with a finer grain of analysis are recommended to address these data gaps. Recommendations of the 2020 study (some which are now underway) include:

#1. Establish an independent noise monitoring authority to determine if thresholds for noise established by the Federal Aviation Authority are adequate given local circumstances, as well as appropriate strategies for mitigating effects.

#2. Expand the study area to include other neighborhoods that may be affected by Seattle-Tacoma International Airport, including West Seattle, Beacon Hill, and Renton.

#3. Develop more detailed public health statistics at the census tract or enumeration district level to afford a more detailed comparison of health effects and airport-related data (noise contours, flight tracks, etc.).

#4. Approve/reauthorize bills to address mitigation packages that have failed or are inadequate.

#5. Audit local building and zoning standards to identify any inconsistencies between local regulations and federal rules.

#6. Identify new construction potentially affected by airport use.

#7. Establish a health effect assessment process to determine potential health effects of new developments.

#8. Require alternative fuel use for airport users.

#9. Expand the late night noise limitation program to reduce effects on neighborhoods.

#10. Replant trees throughout the study area to help absorb noise and air toxins.

#11. Expand Port efforts to promote public health.

Effects on socio-economics

Socio-economic effects vary by city. Benefits include airport employment, hotel tax revenues, relatively higher multi-family and industrial rents, and proximity to air service as a locational advantage for corporate development.

Demographically, the study area trends older (with the exception of the cities of SeaTac and Tukwila). Except for Normandy Park, the study area has a higher percentage of minority population with a lower

income and without a college degree than King County. Study area students come from a higher percentage of minority homes, tended to test lower in arts and math scores, and had higher incidents of obesity. The study area has slower rates of growth and slower increases in home values, with commercial vacancy rates below equilibrium (consistent with many cities since the Great Recession), median household incomes below the average for King County, and more owner-occupied households that spend 30% or more of their income for housing. However, it could not be determined if these are due to airport proximity or other factors. Recommendations of the 2020 study include:

#1. All parties should commit to a shared objective.

#2. Consider a "study area-wide" overlay district.

#3. Conduct additional analyses.

Summary of study area effects

The following presents a general assessment of the all of the effects in the study area attributable to aviation activity, categorized into four effect types. There are numerous data gaps that have been identified in the 2020 study that are recommended for additional study and analysis.

Summary of Study Area Effects Attributable to Aviation Activity – 1997 to 2019

■ Positive effect attributable to aviation activity
■ Negative effect attributable to aviation activity
■ Neutral/no effect attributable to aviation activity
○ Inconclusive data/needs additional study

METRIC	STUDY AREA CITY																	
	Burien			Des Moines			Federal Way			Normandy Park			SeaTac			Tukwila		
	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019
EFFECTS FROM NOISE & VIBRATION																		
Noise	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	○	○	○
Vibration	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
EFFECTS ON AIR QUALITY																		
CO	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
HC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
NO_X	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
SO_2	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
VOC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
PM_{10}	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
$PM_{2.5}$	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
UFP's	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Summary of Study Area Effects Attributable to Aviation Activity – 1997 to 2019

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METRIC	STUDY AREA CITY																	
	Burien			Des Moines			Federal Way			Normandy Park			SeaTac			Tukwila		
	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019
EFFECTS ON MOBILITY																		
Traffic	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Transit/Rail	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Transit/Bus	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Parking	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■
Bicycle	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Pedestrian	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
EFFECTS ON SURFACE WATER																		
Stormwater Runoff	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Floodplains	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Wetlands	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
EFFECTS ON GROUNDWATER & SOIL																		
Groundwater	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Soil	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
EFFECTS FROM LIGHT																		
Light	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
EFFECTS ON PUBLIC HEALTH																		
Cancer	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Heart Disease	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Alzheimer's Disease	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Chronic Lower Respiratory Disease	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Stroke	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Accidents and External Causes	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Suicide	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Life Expectancy	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Maternal and Child Health	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Access to Care	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
EFFECTS ON PUBLIC SAFETY																		
Violent Crime	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Property Crime	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Motor Vehicle Theft	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Human Trafficking	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Drug Trafficking	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Summary of Study Area Effects Attributable to Aviation Activity – 1997 to 2019 (continued)

■ Positive effect attributable to aviation activity
■ Negative effect attributable to aviation activity
■ Neutral/no effect attributable to aviation activity
○ Inconclusive data/needs additional study

METRIC	STUDY AREA CITY																	
	Burien			Des Moines			Federal Way			Normandy Park			SeaTac			Tukwila		
	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019
EFFECTS ON SOCIO-ECONOMICS																		
Housing	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■
Employment	■	■	■	■	■	■	■	■	■	○	○	○	■	■	■	■	■	■
Retail Market	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■	■	■	■
Office Market	○	○	○	■	■	■	○	○	○	■	■	■	■	■	■	○	○	○
Industrial Market	■	■	■	■	■	■	○	○	○	■	■	■	○	○	○	○	○	○
Hotel Revenue	■	■	■	■	■	■	○	○	○	○	○	○	■	■	■	■	■	■
Tax Revenues	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■	○	○	○

*** * * E N D * * ***

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

A. BASIS FOR THE STUDY

The Washington State Legislature asked the Department of Commerce in March 2018 to implement the provisions of (Proviso) Section 127(63) of Engrossed Substitute Senate Bill (ESSB 6032) using the following language:

"(63) (a) $300,000 of the general fund—state appropriation for fiscal year 2019 and $300,000 of the general fund—local appropriation are provided solely for the department to contract with a consultant to study the current and ongoing impacts of the Seattle-Tacoma international airport. The general fund—state funding provided in this subsection serves as a state match and may not be spent unless $300,000 of local matching funds is transferred to the department.

(b) The final study scope shall be developed by the department, in consultation with organizations or entities including members of the legislature, the port of Seattle, and the cities listed in subsection (c)(i),

(c) The study scope must include, but not be limited to:

(i) The impacts that the current and ongoing airport operations have air traffic noise, public health, traffic, congestion, and parking in residential areas, effects on residential and nonresidential property values, and economic development opportunities, in the cities of SeaTac, Burien, Des Moines, Tukwila, Federal Way, Normandy Park;

(ii) The benefits to the same cities referenced in (c)(i) derived due to proximity to the airport, including wages and taxes from airport-related operations, property tax derived from commercial development directly tied to airport-related operations, and improved access to transit resulting from proximity to the airport; and

(iii) Options and recommendations for mitigating any negative impacts, or bolstering potential benefits identified through the analysis, including what role the state plays in addressing impacts and benefits.

(iv) The department must collect data and relevant information from various sources including the port of Seattle, listed cities and communities, regional planning agencies, and other studies.

(v) The study must be delivered to the legislature by December 1, 2019."

The legislature since revised the delivery date of the study from Dec. 1, 2019 to June 1, 2020 via Engrossed House Bill (ESHB) 119 Section 129.

This study (the "2020 study") acknowledges the importance of Seattle-Tacoma International Airport, not only to the Seattle region but to the state of Washington and should **not** be construed as "anti-airport" in any fashion.

The 2020 study was based on an objective and independent review and evaluation of existing data to assess the effects that airport operations might have on the six cities referenced above – Burien, Des Moines, Federal Way, Normandy Park, the city of SeaTac, and Tukwila – an area that includes over 237,000 residents and covers over 61 square miles. The consultants gathered information from over 400 technical references and met with over 200 people while investigating eight general areas over a 22-year period (1997 through 2019), including:

- Air quality
- Noise
- Environmental effects
- Mobility
- Light
- Public safety
- Public health
- Socio-economics

For each study area city, the consultants researched over 65 data points between 1997 and 2019 – over 8,500 data points total. Anecdotal information from study area residents and business owners was also considered.

It is important to note that this study (hereafter referred to as the 2020 study) is not to oppose or impede the operations, growth, or success of Seattle-Tacoma International Airport. While there is some similarity to a 1997 study regarding the third runway, it is not an extension or continuation of that 1997 study.

Difference between the 1997 study and the 2020 study

The 1997 study – the "Sea-Tac International Airport Mitigation Study" (February 1997) – was authorized by a 1995 grant by then-State Sen. Mike Heavy and was administered by the Department of Commerce's predecessor (the Department of Community, Trade, and Economic Development, known as CTED). It was in response to concerns regarding the potential for increased aviation-related effects upon neighboring communities as a result of Seattle-Tacoma International Airport's then-proposed third runway. The 1997 study was tasked with assessing the third runway's projected construction and operational effects of the then-proposed third runway, and developing mitigation strategies for the cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital. That study was completed in February 1997.

The 1997 study reviewed the draft environmental impact statement (EIS) and considered how an expanded Seattle-Tacoma International Airport with the third runway would affect its surrounding communities.

The 2020 study looks at historical data between 1997 and roughly 2019 and seeks to establish a baseline of ongoing airport operations using a variety of metrics. The 2020 study does not include new modelling or sampling, nor should it be considered in any way to be an EIS or an environmental assessment (EA).

The two studies are not the same, have slightly different study areas, and are not to be considered as directly related. Where the 1997 study projected future potential conditions based on an EIS, the 2020 study evaluates historical data for the last 23 years. It is not an extension of the 1997 study.

B. THE CONSULTANT TEAM

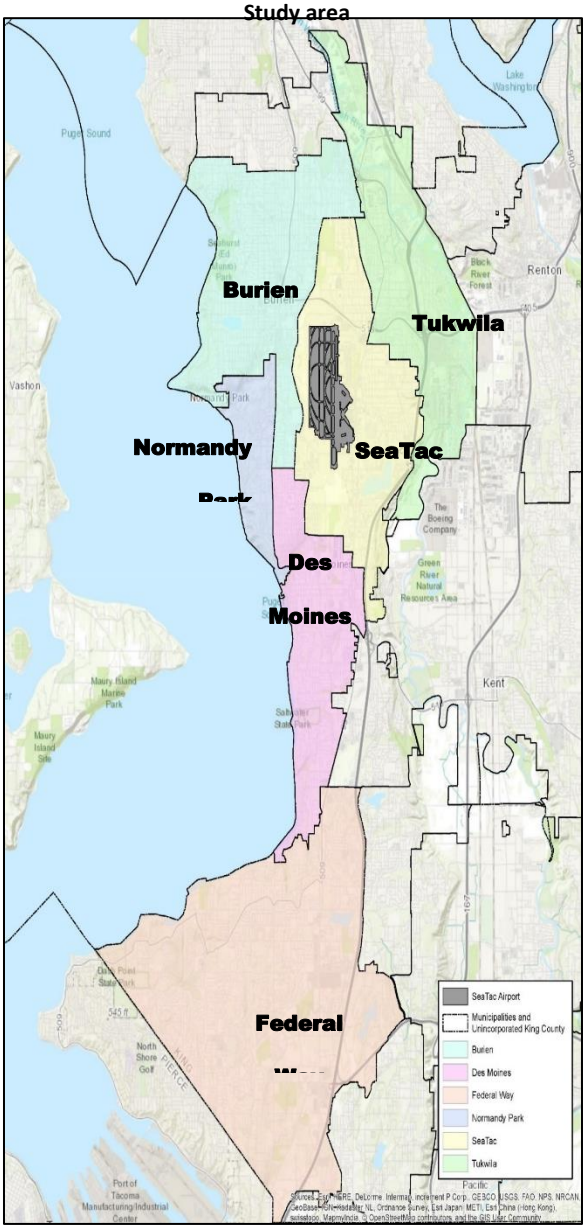
In response to ESSB 6032, the Department of Commerce solicited proposals in early 2019, advertised both locally (metropolitan Seattle area) and nationally. A shortlist was selected for interviews in April 2019 and upon conclusion, a consultant team lead by Stantec was selected to conduct this study.

Stantec is a multi-disciplinary engineering-planning-architecture firm with offices worldwide. The Stantec team includes staff from the Seattle metropolitan region as well as other offices. (The Stantec project director leading this effort also led the 1997 study while with a previous firm.)

As part of the Stantec team, Denver-based Ricker Cunningham is providing real estate economics, community strategies and addressing quality of life indicators for the study area. Ricker Cunningham and the leadership of the Stantec team have more than 20 years of experience working together on similar projects.

Figure 1

Study area



C. THE STUDY AREA

The 1997 and 2020 studies do have some degree of similarity in that the cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila were included in both studies (the city of SeaTac was not officially a part of the 1997 Study). While the 2020 study does not include the Highline School District and the Highline Community Hospital, the expansion of the city of Burien's corporate limits now includes many of these same areas. Figure 1 shows a map of the study area, and Figure 2 details the six study area cities.

The study area covers 61.36 square miles (approximately 2.65% of the total area of King County), but its population of represents 10.7% of King County's population (237,498 people).

The study area's density is roughly 3.3 times greater than the county average – 3,396.3 persons per square mile in the study area versus 1,034 in King County. This indicated that the study area is more densely populated and more urbanized than the average in King County. This concentration of population close to Seattle-Tacoma International Airport has contributed to concerns regarding the compatibility of airport operations, going back many decades.

Figure 2
Study area cities

City	Incorporated	Total Area (in square miles)	2018 Population	Average Density (people per square mile)
City of Burien	1993	10.11	51,908	5,134.3/sq. mi.
City of Des Moines	1959	6.41	32,364	5,049.0/sq. mi.
City of Federal Way	1990	22.49	97,044	4,330.4/sq. mi
City of Normandy Park	1953	2.51	6,649	2,649.0/sq. mi.

City of SeaTac	1990	* 10.24	29,239	* 2,855.4/sq. mi.
City of Tukwila	1908	9.60	20,294	2,113.9/sq. mi.
	TOTALS	**61.36**	**237,498**	**3,870.6/sq. mi.**

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census

* According to officials from the city of SeaTac, approximately 40% of the city's 10.24 square mile area is composed of Seattle-Tacoma International Airport land, making the non-airport portion of the city approximately 6.15 square miles. Using this adjusted area, the average density increases to 4,754.3 persons per square mile (up from 2,855.4 as shown in Figure 2), making it the third most densely-populated study area city behind Burien and Des Moines.

D. STUDY APPROACH

The purpose of the 2020 study is to **objectively** and **independently** evaluate and assess a variety of effects (positive, negative and neutral) associated with the operation of Seattle-Tacoma International Airport and to establish a baseline that may be used to evaluate current and future operations:

- Positive effects include such factors as higher-paying jobs, increased tax revenue, etc.
- Negative effects include such factors as concerns about noise, air quality, public health, etc.
- Neutral effects are those with little to no measurable positive or negative effect.

This evaluation and assessment were limited to existing data covering the period from 1997 through 2019. No additional sampling, modelling, or new data collection was included in the scope of the study.

As part of the 2020 study, the consultant teams presented regular updates to an advisory committee and held two public workshops for public input. The consultant team also met with city staff, elected officials, staff from the Port of Seattle, and representatives from various public agencies city to gather data.

While the 2020 study acknowledges the importance of Seattle-Tacoma International Airport as a significant regional and statewide asset, the 2020 study remains independent and takes no sides. The 2020 study does not argue for or against Seattle-Tacoma International Airport, nor does it advocate for any city, neighborhood, organization, or resident. The 2020 study attempts to address the following basic questions:

- Do the study area cities enjoy any benefits by being close to Seattle-Tacoma International Airport?
- Are the study area cities shouldering a regionally disproportionate burden because of their location?

These questions are not easily answered. In the years between the 1997 and 2020 studies, the region (as well as the study area cities) have experienced multiple changes, and there has been ongoing regional growth that has roughly doubled the population of the Seattle metropolitan area. The 2020 study is tasked with determining:

- What effects are directly related to Seattle-Tacoma International Airport operations (direct effects)?
- What effects are the result of natural organic regional growth (induced effects)?

The approach to this study makes the following assumptions:

- **Available data**
  The 2020 study is based on the analysis and evaluation of available existing data from 1997 through 2019 to assess any effects associated with Seattle-Tacoma International Airport. Information to be reviewed comes from diverse sources, including the Port of Seattle, the study area cities, King County, the city of Seattle, the Puget Sound Regional Council (PSRC), various state and federal agencies, etc.
- **No new modelling, sampling or data collection**

The 2020 study is based on existing data and does not generate new information through modelling, sampling, or other data collection. (The project scope, budget and schedule did not allow for new modelling and data collection tasks).

- **Public input**
  The 2020 study considers and evaluates information provided by individual citizens from the study area cities, provided that the information can be independently verified or validated. Information that could not be verified or validated is considered part of the anecdotal public input component to help identify additional concerns with airport operations.

- **Milestone dates**
  The 2020 study uses the following milestone years to evaluate potential effects experienced in the study area cities that may be attributable to aviation-related activity:
  - **1997** – The base year using information available from the 1997 study.
  - **2009** – The first full year of operations of the third runway.
  - **2019** – The most current year of available data (depending on how the data is collected, the "present" year sometimes varies between 2018 and 2019).

- **Evaluation standards**
  The 2020 study evaluates and assesses various metrics experienced by the study area cities based on appropriate existing state and federal legislation, policies, and regulations. The existence of proposed metrics, ongoing research and international studies, while of interest, are not currently enforceable but may be relevant in the future.

E. THE TECHNICAL ADVISORY COMMITTEE

A technical advisory committee (TAC) was established to provide guidance and input to the consultant team, as well as to present a variety of draft information for review and discussion. The TAC was composed of staff and citizen representatives from each study area city, as well as two members of the Washington State Legislature. Several members of the Department of Commerce staff also attended TAC meetings. Many of the TAC members are also members of local airport committees in their respective study area cities.

Figure 3
Technical Advisory Committee

Organization	Name	Role
City of Burien	Rose Clark Brian Wilson	Citizen representative City Manager
City of Des Moines	Steve Edmiston Michael Matthias	Citizen representative City Manager
City of Federal Way	David Berger Bill Vadino	Citizen representative Policy Advisor to the Mayor
City of Normandy Park	Mark Hoppen Kathleen Waters	City Manager Citizen representative
City of SeaTac	Steve Pilcher, Roger Kadeg	Director of Community & Economic Development Citizen tepresentative
City of Tukwila	Brandon Miles Jim Haggerton	Economic Development Liaison, Mayor's Office Citizen representative
Washington State Legislature	Rep. Tina Orwall Rep. Mike Pellicciotti	33rd Legislative District 30th Legislative District
Washington Department of Commerce	Gary Idleburg Dave Anderson Mark Barkley Matthew Ojennus *Mark McCaskill* *Ike Nwankwo*	Project manager Managing director Assistant director, Local Government Division Senior planner *Director, Growth Management Services Unit (former)* *Western Washington manager (retired)*

(Note: Names in *italics* are Department of Commerce staff who left the agency prior to the completion of the project.)

TAC meetings were conducted monthly at the city of SeaTac City Council Chambers (with the exception of the Oct. 28, 2019 TAC meeting held at North Highline Fire Station #18 while the SeaTac City Council Chamber was being renovated).

TAC meetings were not intended to be public meetings and did not include opportunities for public comment or discussion. Other opportunities for public input were provided during the 2020 study (described in the following section).

F. PUBLIC INPUT OPPORTUNITIES

As noted, the purpose of the 2020 study was to conduct an independent and objective evaluation of Seattle-Tacoma International Airport operations – both positive and negative – and not to advocate on behalf of any single individual or community. The 2020 study was not intended to serve as a public forum for commentary on various aspects of Seattle-Tacoma International Airport.

During the course of the 2020 study, additional data was offered to the consultant team from study area citizens. The consultant team used data that could be independently verified and validated. Information that could not be verified/validated was considered as anecdotal input, which also helped the consultant team identify issues important to the public.

Information and insight from the public were provided during the 2020 study, and several opportunities were provided for public input:

- **June and July 2019 – Stakeholder interviews**
  A series of interviews was conducted with nearly 50 stakeholders representing the study area cities (stakeholders were named by each individual city).
- **July 24, 2019 – Public workshop #1**
  The first workshop was held at Tyee High School (city of SeaTac) to present the study's approach, scope, and schedule. Public comments were taken via in-person 1-to-1 meetings and through a comment board.
- **Nov. 6, 2019 – Public workshop #2**
  The second workshop was held at the Burien City Hall/Library to present draft research observations. Public comments were taken via Q&A session and through written comment cards.
- **Sept 16, 2019 and Nov. 20, 2019 – Mitigation package meetings**
  Meetings conducted by State Rep. Tina Orwall regarding citizen concerns with the mitigation packages offered by the Port of Seattle.
- **Nov. 12, 2019 – Mitigation and UFP meeting**
  A meeting was conducted by State Rep. Tina Orwall and State Sen. Karen Kaiser regarding citizen mitigation issues and an update of the ultra-fine particulate study from the University of Washington researchers.
- **Jan. 6, 2020 – Special TAC meeting**
  A special TAC meeting was conducted at the city of SeaTac City Council Chambers with selected citizen representatives invited held to solicit additional detailed input on the study's approach and findings.
- **April 1, 2020 – Online summary**
  An online video summary of the 2020 study was made available for download by anyone from the Department of Commerce's website, accompanied by an abstract of the draft report's executive summary.

Some citizens stated that the 2020 study did not go far enough in advocating for their interests or did not extend geographically to neighborhoods that were not part of the ESSB 6032 study grant area. The study area cities were defined by ESSB 6032 and the project's scope, schedule and budget defined what the consultant team could focus on during the project schedule. Further evaluation and analysis outside these parameters could be accommodated as part of a follow-up study.

Many residents voiced long-standing concerns about how operations at Seattle-Tacoma International Airport have affected their communities, and in some cases their individual homes. Some of these concerns date back to 1970 and the opening of the second runway. Concerns range from the quality of noise mitigation packages to nighttime passenger and cargo flights to issues regarding property values and effects on public health.

While the consultant team acknowledges the importance of these issues, the 2020 study was not designed to be a forum for additional concerns regarding Seattle-Tacoma International Airport. As mentioned, public input did help determine the magnitude of some concerns, especially where data was unavailable, inconsistent, or incomplete. Those disparities are noted as part of this study.

An unexpected problem

Beginning in early 2020, an unanticipated problem derailed the remainder of public meetings and presentations. The Seattle region experienced one of the early U.S. outbreaks of the COVID-19 coronavirus – a global pandemic that resulted in nationwide and international travel restrictions and regionwide shelter-in-place orders. From March through June 2020, this order prevented the consultant team from presenting the 2020 study's findings, including in-person presentations to the TAC, to each study area city council, to the Department of Commerce leadership, and to state legislators and other interested parties.

Alternatively, an online TAC meeting was conducted in mid-March 2020, and a narrated video summary of the report was posted online in April 2020 for public review. The draft report was also posted on the Department of Commerce website for review and comment during this same period. Ongoing health concerns prevented final in-person presentations in May 2020.

G. THE SHARED HISTORY OF THE STUDY AREA

The study area has been inhabited by for hundreds (perhaps thousands) of years prior to the development of Seattle-Tacoma International Airport. It was initially the home to the Lushootseed-speaking tribes of the Muckleshoot, Puyallup, Duwamish, and Suquamish peoples who established encampments for fishing, clamming, hunting and agriculture. By the mid-1800s, settlers and homesteaders began establishing small communities throughout the area.

As is common with metropolitan areas, the six study area cities grew at different paces. Tukwila was the first to incorporate as a city (1908), with Normandy Park and Federal Way becoming cities in the 1950s (1953 and 1959, respectively). Federal Way and SeaTac both incorporated on the same day in 1990, with Burien officially becoming a city in 1993. And while they all incorporated at different times, they all were growing as early "suburbs" to the larger city of Seattle.

Burien, Normandy Park and Federal Way were developing neighborhoods and communities that had a combination of Puget Sound views, dramatic topography, and dense tree cover. Some referred to Normandy Park as "Boeing-ville" because of the number of Boeing executives who resided in the community.

All study area cities leveraged some mode of transportation – highway, railroad, or boat – as a means to grow. Tukwila's strategic location along Interstate 5 and railroad freight lines helped it become a leader in retail and warehouse/distribution development.

An industry closely tied to Seattle and King County is aviation, and aircraft manufacturer Boeing has been an important part of the region for over 100 years. Interest in aviation accelerated after World War I, initially for mail and cargo delivery, then for commercial routes in the 1920s. Boeing Field (King County International Airport) began offering passenger service in 1928 and was eventually replaced by Seattle-Tacoma International Airport as the region's main passenger airport in 1947. (The U.S. military had taken control of Boeing Field in the 1940s as a response to the 1941 attack on Pearl Harbor, Hawaii.)

Despite "growing up together", many of the study area cities have had previous concerns with operations at Seattle-Tacoma International Airport, including the development of the second runway in 1970 (Runway 16C/34C) and its associated noise and air quality. Those concerns were echoed 27 years later with the 1997 proposal of a third runway (Runway 16R/34L). Both runways were constructed despite local objections.

Study area growth

From 2000 to 2018, the entire study area, as well as the City of Seattle, King County, and the Seattle metropolitan statistical area (MSA) experienced growth, but at varying rates – from 22.8% for the study area to 32.2% for the city of Seattle. (The city of Burien's growth rate was also partially the result of a significant annexation in 2010 that added 1,600 acres and 14,292 residents to the city at once. Without the 2010 annexation, Burien's growth rate would have been closer to 20%.)

Figure 4
Area Growth: 2000-2018

Area	2000 Population	2018 Population	Growth: 2000-2018
City of Burien	31,881	51,908	62.8%
City of Des Moines	29,267	32,364	10.6%
City of Federal Way	83,259	97,044	16.6%
City of Normandy Park	6,392	6,660	4.0%
City of SeaTac	25,496	29,239	14.7%
City of Tukwila	17,181	20,294	18.1%
Total: Study area cities	**193,476**	**237,449**	**22.8%**
City of Seattle	563,374	744,955	32.2%
King County	1,737,034	2,233,163	28.6%
Seattle MSA	3,043,878	3,939,363	29.4%
Seattle-Tacoma International Airport	**2000 Passengers**	**2018 Passengers**	**Growth: 2000-2018**
Total Annual Passengers	**28,408,553**	**49,849,520**	**75.5%**
Seattle-Tacoma International Airport	**2000 Operations**	**2018 Operations**	**Growth: 2000-2018**
Air Carrier	236,355	427,170	80.7%
Air Taxi	203,723	8,509	(-95.8%)
General Aviation	5,448	2,625	(-51.8%)
Military	95	87	(-8.4%)
Civil	56	0	(-100.0%)
Total Annual Operations	**445,677**	**438,391**	**(-1.6%)**

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census

Although the study area is growing, it is not growing as fast as other parts of the area (refer to Figure 3). However, the largest growth rate in the study area (2000 to 2018) is associated with both the number of passengers at Seattle-Tacoma International Airport (75.5%) and air carrier operations (80.7%). Non-air carrier operations (including air taxi, general aviation, military and civil operations) all decreased during the same period, indicating a rise in the prominence of commercial activity (passenger and cargo) at Seattle-Tacoma International Airport.

Based solely on the above data, no direct correlation can be made between dramatic growth at the Seattle-Tacoma International Airport and the slower growth rates in the study area cities.

Since the above data was initially collected, the Port of Seattle published the 2019 annual passenger and operation counts. The 2019 annual passenger count increased 6.2% over 2018 (to 51,829,239 passengers), while operations fell 5.8% from the previous year (down to 412,916). This disparity may be related to increasing seat count in aircraft and/or the use of larger aircraft on select routes.

H. AIRPORT CASE STUDIES

The 2020 study examined three other airports that shared similar characteristics with Seattle-Tacoma International Airport – U.S. airports with international service with similar land area that are surrounded by other development or by water. The three case study airports were:

- Boston Logan International Airport (Boston, Massachusetts).
- Miami International Airport (Miami, Florida).
- Phoenix Sky Harbor International Airport (Phoenix, Arizona).

Figure 5

Airport Comparisons

Attribute	Seattle-Tacoma	Boston Logan	Miami	Phoenix Sky Harbor
Year opened	1944	1923	1928	1928
Size (acres)	2,500 acres	2,384 acres	3,230 acres	3,400 acres
# of runways	3 runways	6 runways	4 runways	3 runways
# of terminals	3 terminals	4 terminals	4 terminals	3 terminals
# of gates	80 gates	103 gates	131 gates	116 gates
Passengers (2018)	49,849,520	40,941,925	45,044,312	44,943,686
Operations (2018)	438,391	424,024	416,032	434,252
Efficiency ratios (2018):				
▪ **Annual passengers per operation**	113.7	96.6	108.3	103.5
▪ **Annual passengers per gate**	623,119.0	397,494.4	343,849.7	387,445.6
▪ **Daily passengers per gate**	1,707.2	1,089.0	942.0	1,061.5

Figure 5 shows the comparison of the above airports with Seattle-Tacoma International Airport. All three airports had concerns with noise affecting surrounding residential areas and addressed them in different ways. Other comparisons include:

- Seattle-Tacoma International Airport is a very efficient facility. It has the highest ratio of passengers per operation and handles over 1,700 passengers per gate per day every day (2018 annual average).
- The experience of Phoenix Sky Harbor with the NextGen procedures is similar to that experienced in the study area cities.
- The land use redevelopment strategy at Phoenix Sky Harbor went beyond standard mitigation practices. Phoenix is working with the community to return acquired parcels to active development, adding jobs and revenue back into the region.

- Miami's community outreach programs, including a van equipped with mobile noise monitors, was the most far-reaching effort of the airports studied. The designed "art noise" wall, while not a perfect solution, was an indicator of Massport's interest in providing some measure of abatement approaches that are sensitive to its surroundings. Boston also had a more extensive community outreach effort. Both Miami and Boston implemented policies and procedures designed to protect the environment, from ISO certification to LEED building practices to how aircraft are powered and cooled while parked at the gate.

While the above case studies do not cover every comparable U.S. airport to Seattle-Tacoma International Airport, they indicate what comparable airports are doing to address community concerns.

This should **not** be interpreted in any way as a critique or condemnation of the efforts to date by the Port of Seattle. It does indicate what the case study airports with similar annual passenger and operation performance have done to address community concerns regarding their facilities. A more extensive survey is recommended to get a more complete picture of how U.S. airports comparable to Seattle-Tacoma International Airport address their community compatibility issues.

I. THE NATIONAL PLAN OF INTEGRATED AIRPORT SYSTEMS

Every two years, the U.S. Secretary of Transportation is required to submit to Congress the National Plan of Integrated Airport Systems (NPIAS) that "estimates the costs associated with establishing a system of airports that adequately meets the needs of civil aviation and supports the U.S. Department of Defense and the U.S. Postal Service."

This is the mechanism for developing public-use airports in the U.S. and supports the U.S. Department of Transportation's (DOT) and the Federal Aviation Administration's goals of safety, infrastructure, innovation, and accountability as mandated by Title 49 USC, Section 47103.

On page 1 of the most recent Report to Congress (26 September 2018), the NPIAS defines a list of eight attributes to be followed. These principles were articulated more than 25 years ago and were reaffirmed by both the Federal Aviation Administration and the aviation industry in 2011. Of the eight attributes, Principle #5 is appropriate with regards to how airport-area communities are addressed:

> **"Airports should be compatible with surrounding communities, maintaining a balance between the needs of aviation, the environment, and the requirements of residents."**

Additionally, Executive Order 12893 (31 January 1994) requires that "federal investments should be cost beneficial". This executive order included other key principles that the Federal Aviation Administration supports through its administration of the NPIAS, including:

- Support of state and local planning and information management systems.
- Support for private sector participation.
- Support for effective administration of grant programs like airport improvement program (AIP).

Given that every U.S. airport is required to abide by the attributes and guiding principles established in the NPIAS, this study recommends that the Port of Seattle and Seattle-Tacoma International Airport take these principles into account, especially Principle #5 regarding compatibility with surrounding communities.

J. WHAT WE HEARD FROM THE PUBLIC

In addition to research data over a 22-year period, the consultant team received input from the public to help establish the concerns and priorities that were concerns of the residents of the study area. Public input was gathered in a variety of ways, including:

- A series of 1-to-1 and small group stakeholder interviews composed of citizens, homeowners, business owners, and other interests in the study area cities.
- Two public workshops (July 2019 and November 2019) to gather public comment regarding the 2020 study and draft preliminary findings.

During this process, almost 200 people were involved, including both long-time and new residents. The top concerns voiced were regarding noise and air quality:

- **Noise**

  Noise was the primary concern among the residents who commented during the 2020 study. Noise complaints date back to the development of the third runway more than 20 years ago (and some go as far back as the second runway in 1970). Noise-related complaints were relatively constant from 1997 until 2017 with a few thousand each year. Complaints spiked dramatically in 2018 (over 170,000 complaints) and 2019 (over 400,000 complaints). This spike in 2018 and 2019 is consistent with the increase in annual operations and annual passengers at Seattle-Tacoma International Airport.

  The Port of Seattle also indicated that the dramatic increase in noise complaints after 2017 was due in part to the development of an app that allowed for noise complaints to be submitted automatically to the airport with the push of a button. The Port of Seattle also reports that this app is used for airports nationwide, not just Seattle-Tacoma International Airport.

- **Air Quality**

  Air quality concerns were a close second concerns, especially how air quality can affect health, the environment, property values, and quality of life. A new category of air pollutant – ultrafine particulates (UFPs) – was also a concern of the public. (A concurrent study on UFPs was being conducted by the University of Washington, which did not detail effects on human health.)

Other concerns raised by the public during the 2020 study included (not in order of importance or priority):

- Failure of mitigation packages as part of the third runway mitigation process.
- Traffic congestion, specifically on Airport Expressway, along International Boulevard/US Highway 99 at Arrivals Drive/South 182nd Street, on State Route 518 westbound (west of the I-5/I-405 interchange), and State Route 518 eastbound (west of the Des Moines Memorial Drive interchange).
- Concerns that South King County is a "dumping ground" for undesirable land uses. Examples given included the Federal Detention Center (2425 S. 200th St.) and the Federal Aviation Administration Flight Standards District Office (2200 S. 216th St.) – neither of which contributes property tax revenues to the local communities.
- A general mistrust by members of the public of the Federal Aviation Administration, the Port of Seattle, and Seattle-Tacoma International Airport. This level of skepticism appears to most acute in Burien, Des Moines, Federal Way, and Normandy Park. However, it is important to note that this is not uniform across the study area. For instance, the city of SeaTac has reported that its working relationship with the Port of Seattle is quite good, as evidenced by an interlocal agreement between the two entities.
- Violent crime, property crime, and motor vehicle theft in the study area cities is disproportionate.
- Property crime activity in the study area cities is disproportionate.
- Motor vehicle theft and related activity in the study area cities is disproportionate.

- Homelessness is a regional problem and is pervasive near the airport.
- Airport proximity influences health statistics.
- Airport proximity exceeds appropriate health standards.
- There are noise-induced health concerns.
- Port of Seattle programs and other efforts (sustainability and fly quiet) have been ineffective.
- Previous noise mitigation packages are ineffective.
- The relationship with the Port is generally poor, but also varies by community.
- Airport revenues are not shared with South King County communities.
- The most vulnerable groups are being the most adversely affected.
- Positive and negative effects vary among the study area cities.
- Housing that is most adversely affected is near the airport.
- School performance has suffered due to airport effects.
- The Port of Seattle is not responsive to the cities in the study area.
- NextGen procedures have enhanced adverse effects.
- Airport employment levels for area residents are not what they used to be.

Some citizens provided data and studies regarding noise and air quality to the consultant team. This information was reviewed and included in the 2020 study only when it could be independently verified and validated. When that was not possible, the information was taken as an anecdotal indicator of public concern regarding specific aspects of the airport and its operation.

It is important to note that the public did not speak with a "unified monolithic voice." Concerns varied from city to city within the study area:

- Input from those west and south of the airport tended to prioritize noise and air quality as primary concerns (predominantly Burien, Des Moines, Normandy Park and Federal Way, with some areas in the city of SeaTac immediately north of the airport).
- Those living northeast and east of the airport tended to also have issues with noise from Boeing Field/King County International, noted more concerns with traffic, and were interested in ways to increase and improve economic development.

Public anecdotal information is important in that it may augment gaps in objective data. These comments tend to point to areas of concern that should be addressed on a local or a community-wide level. It also helped inform the consultant team regarding the recommendations included in this document.

K. EFFECTS FROM NOISE AND VIBRATION

The consultant team was tasked with evaluating a variety of effects to determine a baseline of what effect Seattle-Tacoma International Airport has on the study area cities. Effects were studied as far back as 1997 and up to the most currently available data – usually 2018 or 2019. As noted, input was also considered through stakeholder interviews, public workshops, and monthly meetings with the TAC.

The following were the effects from noise and vibration in the study area.

- **Positive effects of noise and vibration**
  There are no known positive results of receiving noise or vibration.

- **Neutral effects of noise and vibration**
  There are no known neutral results of receiving noise or vibration.

- **Negative effects of noise and vibration**
  As stated above, noise was the top concern voiced by residents of the study area. This was not entirely unexpected, as similar complaints were raised in the 1997 study, and noise is often a common critique of airports by their surrounding communities. While an average residential structure can provide some measure of sound attenuation, there is no known technology that mitigates noise effects in outdoor areas (yards, parks, etc.). Increases in air carrier operations at Seattle-Tacoma International Airport from 1997 to 2019 have also seen an increase in the number of complaints, as well as concerns of adverse associated effects of noise exposure, including:

  - Annoyance
  - Sleep disturbance
  - Cardiovascular effects
  - Children's learning and cognitive impairment
  - Speech interference
  - Depressed property values
  - Effects on wildlife and domestic pets.

  The incidence of noise related complaints generally aligns with flight tracks, late-night operations, and occasional on-airfield maintenance run-ups and reverse thrusting. Despite being in what federal standards consider to be "acceptable," many of these complaints are located within the 65 day-night average noise level (DNL) contour. The DNL method of averaging noise over a 24-hour period is not an accurate representation of how area residents, workers, and visitors experience noise, which is as an individual single event.

- **Noise and vibration data gaps**
  Insufficient data was found to make a determination regarding how vibration affects the study area. Additional study, monitoring and data collection would be necessary to make any determinations regarding vibration.

L. EFFECTS ON AIR QUALITY

The data regarding air quality does not tell the whole story regarding study area effects. While the data indicates that King County is in attainment with federal standards, the lack of working air quality monitors in the study area does not accurately depict the study area's air quality.

- **Positive effects on air quality**
  Toxic emissions are showing a downward trend, and the airport has taken initiatives to reduce emissions, with a plan to fuel all flights at the airport with sustainable aviation fuels by 2028. But without an adequate and operational air quality monitor network, the effect of these improvements upon the study area cannot be adequately measured.

- **Neutral effects on air quality**
  There are no known neutral effects on air quality in the study area.

- **Negative effects on air quality**
  Despite some positive signs, negative effects on air quality continue:
  - Increased aircraft operations negatively affect local and regional air quality.
  - Reports of "black soot" on study area properties, which requires additional independent testing to determine its chemical composition and source.

- Black carbon emissions from aircraft also contribute to atmospheric warming.
- Concerns about UFP pollution (which requires further study).

- **Air quality data gaps**
  Numerous data gaps affected the 2020 study's ability to specifically list air quality effects, including:
  - The inability to compare data from EDMA to AEDT models.
  - Differences between 2016 and 2017 emissions data.
  - Dated EIS data relating to air quality and emissions.
  - Toxic concentration information that is not based on data from monitoring stations close to the airport.
  - Additional study on UFPs is needed to determine the extent of potential health effects.

M. EFFECTS ON MOBILITY

Since 1997, the study area, King County, city of Seattle, and the Seattle MSA have all grown. The challenge of the 2020 study was separating regional traffic growth versus traffic growth associated with airport operations.

- **Positive effects on mobility**
  Positive effects include:
  - Airport Expressway – Construction of Airport Expressway provide a direct route to the airport that does not rely on local streets.
  - Transit improvements – Transit use is promoted by Sound Transit's Link light rail line, Express bus, RapidRide service and Park & Ride lots.
  - Cell phone lot – The cell phone lot provides a nearby waiting area for drivers meeting arriving passengers.
  - Consolidated rental car facility – Development of the remote consolidated rental car facility has removed dozens of shuttle buses previously operated by the individual rental car companies.
  - Local street improvements – Traffic flow improvements on local surface roads including center turn lanes and dedicated bus lanes. Also included are improvements to local sidewalks and bike lanes to encourage walking and bike access.
  - Airport employee parking – The Port of Seattle has developed dedicated employee parking areas north and south of the airport.
  - Local parking – Local parking requirements are generally higher than industry standards. Airport-area parking in adjacent neighborhoods is not the problem as was first thought.

- **Neutral effects on mobility**
  There are no known neutral effects on mobility in the study area.

- **Negative effects on mobility**
  Negative effects include:
  - Highway capacity – Since 2000, the capacity of the regional highway network (Interstates 5 and 405, State Routes 509 and 518) has not kept pace with regional population growth. Improvements have favored transit and high-occupancy vehicle (HOV) access (such as HOV lanes and preferential ramp signals.
  - Congestion – During certain peak travel periods (Thanksgiving, Christmas, etc.), there is visible traffic congestion on Airport Expressway, which can backup to connecting highways and local

streets. Average Level of Service (LOS) ratings have worsened since 1997 on surrounding local streets.

- Airport employee parking in Park and Ride lots – Some citizens have noted that airport employees are using Park and Ride facilities, such as the Angle Lake Light Rail Station garage.

- **Mobility data gaps**

  Numerous data gaps regarding mobility were noted kin the 2020 study:

  - It is currently not known what effect on-demand car services (Uber and Lyft, which did not exist in 1997) have on local and regional traffic.
  - While there have been improvements to the transportation network, these have tended to favor transit, pedestrian, and bicycle access. The overall capacity of the area network has not substantially increased since 1997. And while the airport is thought to contribute to local and regional traffic, the data is insufficient to determine the extent of this contribution.

N. EFFECTS ON SURFACE WATER QUALITY

- **Positive effects on surface water quality**

  The Port of Seattle has made several investments in the infrastructure to preserve and protect the quality of surface water, including:

  - Construction of 112 acres of wetland near the airport.
  - Enhanced about two miles of stream habitat, including the relocation of 1,000 feet of Miller Creek's stream channel.
  - Excavated 60-acre feet of floodplain storage capacity.
  - Installed 200 pieces of large woody debris, removed two culverts that blocked fish passage, and focused on stabilizing four eroded portions of Miller Creek's stream channel.
  - Supplements streamflow to Miller and Des Moines creeks every summer to ensure adequate water levels for fish.
  - Created and enhanced 65 acres of off-site wetland and wetland buffer adjacent to the Green River in Auburn to mitigate the loss of wetland habitat for waterfowl near the airport.
  - Upgraded the industrial wastewater system (IWS) and stormwater management systems (SWS) to more efficiently capture and treat stormwater runoff from the airport.
  - Kept stormwater discharges from the airport well below permit limits with low variability in comparison to other airports and industrial stormwater.

  The near-constant monitoring of stormwater runoff water quality required by the National Pollution Discharge Elimination System (NPDES) permitting program and adjustments to stormwater management in response to water quality results leave little in the way of negative effects to surface water quality and habitat in the immediate area. However, Seattle-Tacoma International Airport occasionally exceeds those criteria, and even short-term violations can affect salmon habitats. With instances of pre-spawning mortality already recorded in Miller, Walker, and Des Moines Creeks, and throughout the Puget Sound region, it is important to understand the effects any pollution can have on salmon populations.

- **Neutral effects on surface water quality**

  There are no known neutral effects on surface water quality in the study area.

- **Negative effects on air quality**

  There are no known negative effects on surface water quality in the study area.

O. EFFECTS ON GROUNDWATER AND SOIL

- **Positive effects on groundwater and soil**
  The Port of Seattle, the Department of Ecology, and other agencies have documented incidents of on-airport contaminated and NPDES exceedances. The Port of Seattle has taken steps to address areas of concern, but on-going work and monitoring is required.

- **Neutral effects on groundwater and soil**
  There are no known neutral effects on groundwater and soil in the study area.

- **Negative effects on groundwater and soil**
  Negative effects include:
  - Known on-airport contaminated sites include Budget Auto Facility, Concourse B/Gate B, Continental Airlines Hydrant System, Delta Airlines Auto Gas Tank Cluster, Delta Airlines Fuel Farm, Northwest Airlines Hangar Tanks, Northwest Airlines Fuel Farm, Northwest Airlines Hydrant Systems, South Satellite Baggage Tunnel, Pan Am Airlines Avgas (Aviation Gas) Tanks, Pan Am Airlines Fuel Farm, Consolidated Rental Car Facility, and United Air Lines (UAL) Fuel Farm/Continental Airlines Fuel Farm.
  - Surface water quality exceedances were detected in Miller and Des Moines.

  Negative effects that are not attributable to Seattle-Tacoma International Airport include:
  - According to the Department of Ecology's database, several underground storage tanks not on airport property were noted to be leaking. Any underground storage tanks not on airport property are not problems attributable to aviation activity.
  - There may be long-term effects that were also associated with the operation of the former Asarco Tacoma Smelter (opened in 1917, closed in 1985). Any effects associated with the closed smelter are not attributable to aviation activity.

  Some citizens raised concerns regarding the effect on soils, gardens, and landscaping from "black soot" that they believe are the result of air pollution associated with aircraft. The composition of the reported "black soot" has not been confirmed by the 2020 study. It requires study and analysis by an independent testing laboratory before its source can be attributed.

P. EFFECTS FROM LIGHT

- **Positive effects from light**
  Seattle-Tacoma International Airport is replacing the older-generation of lighting (metal halide) with energy-efficient LED fixtures that also create less glare. This helps to reduce increased skyglow that often is a problem with standard metal halide lighting.

  The data indicates that light intrusion or pollution is being reduced at Seattle-Tacoma International Airport as a result of improving its light fixtures and high-mast lighting.

- **Neutral effects from light**
  There are no known neutral effects from light in the study area.

- **Negative effects on air quality**
  There are no known negative effects from light in the study area.

Q. EFFECTS ON PUBLIC SAFETY

- **Positive effects on public safety**
  Crime has stabilized and, in some cases, decreased in the study area, including motor vehicle thefts, violent crimes, and property crimes. Normandy Park has the lowest incidence of most crimes. However, it could not be determined if these positive effects were attributable to aviation activity or proximity to Seattle-Tacoma International Airport or were due to other contributing factors.

- **Neutral effects on public safety**
  There are no known neutral effects on public safety in the study area.

- **Negative effects on public safety**
  Tukwila reported the highest rate of most reported crimes. It is suspected that this may be due to the location of major regional retail destinations in Tukwila (such as Southcenter Mall), and it may also be possible that more crimes are reported to police in Tukwila than in other study area cities. However, it could not be determined if these negative effects were attributable to aviation activity or proximity to Seattle-Tacoma International Airport or were due to other contributing factors.

- **Public safety data gaps**
  Incidents of human trafficking and drug trafficking were not traceable in the study area due to insufficient readily available data.

R. EFFECTS ON PUBLIC HEALTH

- **Positive effects on public health**
  There are some positive health outcomes in the study area, including decreases in the accident rate, and some declines in the rates of cancer and heart disease in the study area cities and King County between 2012 and 2016. Life expectancy in the study area cities is almost equal to the average for the state of Washington and the U.S. and is only slightly below the King County average. However, it could not be determined if these positive effects were attributable to aviation activity or proximity to Seattle-Tacoma International Airport or were due to national trends or other contributing factors.

- **Neutral effects on public safety**
  There are no known neutral effects on public health in the study area.

- **Negative effects on public safety**
  While negative concerns outweigh positive effects, there are multiple contributing factors that affect public health. These include poor health habits, genetic predisposition, income level, and other diverse sources. The manner that public health statistics were available prevented a local-level analysis for four of the six study area cities. Poor health can have a devastating effect on individuals and families, and there is no current data that indicates it is attributable to aviation activity at Seattle-Tacoma International Airport specifically in the study area. Further research and analysis is recommended.

- **Public health data gaps**
  The way public health information was gathered combined data for several cities (Des Moines/Normandy Park and SeaTac/Tukwila), making local level comparisons impossible. Additional studies with a finer grain of analysis are recommended to address these data gaps.

S. EFFECTS ON SOCIO-ECONOMICS

- **Positive effects on socio-economics**
  Positive effects include Seattle-Tacoma International Airport as a source of employment for the study area cities, revenue from hotel rooms and supporting businesses in the vicinity of the airport, and proximity to air service as a locational advantage for companies within a 30-minute drive of the airport.

- **Neutral effects on socio-economics**
  Neutral effects include lower median home sale prices, areas located farthest from the airport considered more valuable, and commercial vacancy rates well below equilibrium, a consistent trend being experienced in many cities since the Great Recession.

- **Negative effects on socio-economics**
  Negative effects include school districts with a "lower socio-economic profile" than that of King County, median household incomes below the average for King County, and owner-occupied households that spend 30% or more of their income for housing.

- **Socio-economic data gaps**
  Given the existing data, it could not be determined if the study area cities experience slower rates of growth and increase in home values due to airport proximity or due to other factors. The study area cities experience some benefits from airport-related employment and relatively higher multi-family and industrial rents. However, it could not be determined if these were attributable to aviation activity or proximity to Seattle-Tacoma International Airport or were due to other contributing factors.

T. SUMMARY OF AVIATION-RELATED EFFECTS

Figure 6 presents a general assessment of the all of the effects in the study area attributable to aviation activity, categorized into four effect types:

- Positive effect attributable to aviation activity.
- Negative effect attributable to aviation activity.
- Neutral or no effect attributable to aviation activity.
- Inconclusive data/needs additional study.

There are a variety of data gaps and limited information that inhibit the ability to determine the effect aviation activity has on the study area. There are numerous data gaps that have been identified in the 2020 study that are recommended for additional study and analysis.

Figure 6

Summary of Study area Effects Attributable to Aviation Activity – 1997 to 2019

■ Positive effect attributable to aviation activity

■ Neutral/no effect attributable to aviation activity

■ Negative effect attributable to aviation activity

○ Inconclusive data/needs additional study

METRIC	STUDY AREA CITY																	
	Burien			Des Moines			Federal Way			Normandy Park			SeaTac			Tukwila		
	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019
NOISE & VIBRATION																		
Noise	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	○	○	○
Vibration	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Vibration	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
AIR QUALITY																		
CO	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
HC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
NO_X	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
SO_2	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
VOC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
PM_{10}	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
$PM_{2.5}$	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
UFP's	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
MOBILITY																		
Traffic	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Transit/Rail	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Transit/Bus	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Parking	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■
Bicycle	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Pedestrian	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SURFACE WATER																		
Stormwater Runoff	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Floodplains	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Wetlands	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
GROUNDWATER & SOIL																		
Groundwater	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Soil	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
LIGHT																		
Light	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PUBLIC HEALTH																		
Cancer	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Heart Disease	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Alzheimer's Disease	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Figure 6 (continued)

Summary of Study area Effects Attributable to Aviation Activity – 1997 to 2019

■ Positive effect attributable to aviation activity

■ Neutral/no effect attributable to aviation activity

■ Negative effect attributable to aviation activity

○ Inconclusive data/needs additional study

METRIC	STUDY AREA CITY																	
	Burien			Des Moines			Federal Way			Normandy Park			SeaTac			Tukwila		
	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019	1997	2009	2019
PUBLIC HEALTH (continued)																		
Chronic Lower Respiratory Disease	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Stroke	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Accidents & External Causes	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Suicide	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Life Expectancy	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Maternal & Child Health	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Access to Care	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
PUBLIC SAFETY																		
Violent Crime	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Property Crime	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Motor Vehicle Theft	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Human Trafficking	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Drug Trafficking	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
SOCIO-ECONOMIC																		
Housing	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■
Employment	■	■	■	■	■	■	■	■	■	○	○	○	■	■	■	■	■	■
Retail Market	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■	■	■	■
Office Market	○	○	○	■	■	■	○	○	○	■	■	■	■	■	■	○	○	○
Industrial Market	■	■	■	■	■	■	○	○	○	■	■	■	○	○	○	○	○	○
Hotel Revenue	■	■	■	■	■	■	○	○	○	○	○	○	■	■	■	■	■	■
Tax Revenues	○	○	○	○	○	○	○	○	○	○	○	○	■	■	■	○	○	○

U. RECOMMENDATIONS

Figure 7 on the following pages lists 70 recommendations proposed by the consultant team to address effects and concerns in the study area.

The recommendations address the principal concerns of effects from noise and effects upon air quality. Many of the sources of these effects also cross recommendation categories. For example, aircraft overflights that generate complaints about noise also may be sources of air pollution that affect groundwater, soil, surface water, and various socio-economic metrics.

The challenge is that the data sources for all of the metrics researched and evaluated during the study period (1997 to 2018 or 2019) are not always consistent, do not present data in the same fashion from year to year, have changed modelling approaches, or are simply incomplete or non-existent. The 2020 study was limited to researching, evaluating and assessing data from existing and readily available sources. No new modelling, sampling, or data collection was included in the state grant's scope.

"Data gaps" affected the 2020 study's ability to comprehensively assess effects associated with Seattle-Tacoma International Airport given the limitations of schedule, scope and budget. Therefore, more study is necessary to create a longitudinal dataset that can be a more precise and complete picture of effects within the study area. Many of the following recommendations include the need for additional studies to supplement existing data (such as an origin-destination survey that can augment daily traffic counts).

One last area that impeded the consultant team was the project budget. The entire $600,000 was not available to the consultant team, as $100,000 was set aside by the state to cover internal costs. Only 83.3% of the total grant ($500,000) was available for the actual consultant study. By comparison, the budget for the 1997 study administered by the precursor agency (the Department of Commerce, Trade and Economic Development) was $775,000 for a similar study (assessing the effects of the then-proposed third runway). In current dollars, the 1997 study's budget would be over $1.2 million. Therefore, a follow-up Phase 2 study is recommended to address the data gaps noted herein, with an appropriate budget to meet study scope and schedule requirements.

Figure 7
Study Recommendations

Recommendations: Noise and Vibration	
N.1	Develop a set of alternative noise metrics that do not rely on DNL contours.
N.2	Increase the arrival glideslope to a minimum of 3 degrees.
N.3	Conduct an environmental review for flight track changes.
N.4	Institute noise abatement procedures for late-night operations
N.5	Expand noise monitor locations to include study area permanent and mobile monitors.
N.6	Address existing mitigation packages to fix faulty installations.
N.7	Revise the Port Commission makeup to include direct representation from the study area.
N.8	Conduct additional vibrational monitoring in the study area.
N.9	Determine the effects associated with SELs.
N.10	Determine the effectiveness of sound insulation practices, especially those used by the Port of Seattle in its mitigation packages.
Recommendations: Air Quality	
AQ.1	Improve the current monitoring network by increasing the number and location of monitors in and around the airport.
AQ.2	Establish monitoring guidelines for new locations that consider economics, security, logistics, and atmospheric and pollution considerations.
AQ.3	Deploy Purple Air monitors to get a general sample of air quality trends.
AQ.4	Research the connection of ultrafine particles and health effects.
AQ.5	Conduct a study and improve the monitoring network to determine the extent of regional air pollution effects that are directly related to airport activity.
Recommendations: Mobility	
M.1	Generate rental car forecasts for annual service demand.
M.2	Conduct an annual parking demand study for the main parking garage and employee parking lots.
M.3	Conduct an annual cell phone lot demand study to determine if the cell phone lot reduces congestion at the arrivals and departures areas in front of the terminal.
M.4	Inventory private parking lot data to determine the effect on the main parking garage.
M.5	Conduct an airport mobility modes survey to assess how passengers and employees travel to and from the airport.
M.6	Conduct a drop-off/pick-up zone study to assess congestion and vehicle and pedestrian flow in and around the airport property.
M.7	Forecast employee/vendor/tenant demand to ensure there are parking and mobility options to accommodate changing employment.
M.8	Develop an airport parking master plan in collaboration with airport vendors and employees, surrounding cities, King County Metro, and Sound Transit.
M.9	Develop a transportation improvement program database of all historical and current capital improvements in the Seattle-Tacoma International Airport area to demonstrate network changes over time.
M.10	Conduct a rental car origin-destination study to understand vehicle patterns and movements along the transportation network around the facility, as well as understand where vehicles are traveling from to reach the facility.
M.11	Develop a targeted annual traffic monitoring system to create a consistent and reliable database that monitors congestion over time.
M.12	Conduct an annual transit demand analysis to document transit demand in the study area and ways to improve transit ridership to the airport
M.13	Improve use of airport passenger and employee transit.
M.14	Analyze park & ride use to determine how many people use the facilities to access the airport.
M.15	Conduct a park & ride license plate analysis to determine where vehicles originate and to better understand park & ride demand patterns.
M.16	Conduct an off-street parking license plate analysis to understand where vehicles originate from in the study area and the use of certain on-and off-street facilities.
M.17	Conduct a transit origin/destination study to analyze travel patterns and average daily traffic in the study area.
M.18	Conduct an annual pedestrian count to determine the number of people who use the sidewalk along the front of the terminal and the Link Light Rail Airport/SeaTac station pedestrian bridge to access the airport.
M.19	Identify and eliminate pedestrian mobility barriers.

	Figure 7 (continued) Study Recommendations
M.20	Conduct an on-going on-street parking study in Burien, Tukwila, and SeaTac to monitor supply, use, duration, and areas with excessively high use from non-residents.
M.21	Establish an existing/baseline conditions for specific off-and on-street parking facilities in Burien, SeaTac, and Tukwila.
M.22	Establish and maintain a parking supply database to provide insight on parking demand in the area and give local communities an inventory that can be expanded and monitored over time.
M.23	Adopt or expand parking permit programs in Burien and Tukwila to discourage long-term airport passenger and employee parking on residential streets.
M.24	Create an informational program to educate airport employees and passengers regarding local parking restrictions
M.25	The Port of Seattle should adopt a formal policy that prohibits Airport employees from using on-street off-airport parking during working hours.
	Recommendations: Water Quality
WQ.1	Correct potential errors and data gaps to create a more consistent data record.
WQ.2	Improve receiving stream data through more permanent monitoring stations downstream and a suite of water quality parameters that are collected at outfalls regularly to make results more consistent and comparable.
WQ.3	Further study air pollution effects on surface water through independent analyses of citizen-reported pollution samples on surface water locations.
	Recommendations: Groundwater and Soil
GW.1	Conduct independent testing of "black soot" to determine its chemical composition and potential source(s)
GW.2	Conduct ongoing monitoring and sampling of airport operations maintenance area (AOMA) groundwater monitoring wells on a three-year cycle for key indicator parameters.
GW.3	Coordinate with study area comprehensive plans to ensure the ongoing health and preservation of groundwater and soil areas throughout the study area.
	Recommendations: Light
L.1	Update airport high mast lighting and replace with LED sources.
L.2	Adopt study area lighting standards that would establish guidelines for future developments and renovations of existing facilities.
	Recommendations: Public Safety
PS.1	Modify the second level study to include areas to the north of Seattle-Tacoma International Airport.
PS.2	Consider an airport overlay district to address crime on a multi-city level.
PS.3	Pursue multiple approaches to assist victims of sex trafficking
PS.4	Consider CPTED principles in portions of the study area.
	Recommendations: Public Health
PH.1	Establish an independent noise monitoring authority to determine if thresholds for noise established by the Federal Aviation Authority are adequate given local circumstances, as well as appropriate strategies for mitigating effects.
PH.2	Expand the study area to include other neighborhoods that may be affected by Seattle-Tacoma International Airport, including West Seattle, Beacon Hill, and Renton.
PH.3	Develop more detailed public health statistics at the census tract or enumeration district level to afford a more detailed comparison of health effects and airport-related data (noise contours, flight tracks, etc.).
PH.4	Approve/reauthorize bills to address mitigation packages that have failed or are inadequate.
PH.5	Audit local building and zoning standards to identify any inconsistencies between local regulations and federal rules
PH.6	Identify new construction potentially affected by airport use.
PH.7	Establish a health effect assessment process to determine potential health effects of new developments.
PH.8	Require alternative fuel use for airport users.
PH.9	Expand the late night noise limitation program to reduce effect on neighborhoods.
PH.10	Replant trees throughout the study area to help absorb noise and air toxins.
PH.11	Expand Port efforts to promote public health.
	Recommendations: Socio-Economics
SE.1	All parties should commit to a shared objective.
SE.2	Consider a "study area-wide" overlay district.

SE.3	Conduct additional analyses.
Recommendations: General	
G.1	Establish a single source data clearinghouse for effect metrics and data.
G.2	Expand the study area to incorporate areas to the north so that the airport is located in the center of the study area.
G.3	Expand participation by the Port of Seattle in any follow-up studies.
G.4	Improve the airport/community relationship.
G.5	Develop a plan for airport-adjacent perimeter areas.
G.6	Follow NPIAS Attribute #5 regarding surrounding communities.
G.7	Conduct an expanded Phase 2 study.

V. CLIMATE CHANGE

While the issue of climate change was not part of the project scope, the issue arose as a question from several community members during this project. The consultant team was asked "what are you doing to address climate change," and some community members expressed frustration that this was not part of the project.

The consultant team was not asked to investigate any effects that Seattle-Tacoma International Airport might have on climate change. The project resources (time and budget) were also insufficient to address such a broad and complex issue.

The 2020 study agrees with the bulk of climate research – that the climate has been increasingly affected by human activity. This is supported by research by scientists and academicians across the world. In 2016, 196 countries signed the Paris Accords to address climate change and its underlying causes (the U.S. withdrew from the agreement in June 2017).

The 2020 study did not research the issue of aviation-induced climate change, but it was addressed at the 2019 Paris Air Show. An article in Fortune magazine (June 2019) contained the following quote:

> "Aviation currently accounts for around 2.5% of global carbon emissions, and the industry has pledged to halve its 2005-level footprint by 2050 through an offsetting program. Therefore, engineering firms were keen to showcase a range of eco-friendly inventions such as hybrid engines, urban mobility vehicles, and autonomous flight systems at the annual event, the largest for the aerospace industry. . . .It's not just environmental considerations driving the research: UBS estimates sales of hybrid engines will be worth $178 billion by 2040, while the electric vertical take-off and landing (eVTOL) market will be a $285 billion business by 2030."

The above quote did not specify which components of "aviation" account for 2.5% of global carbon emissions nor the source of this figure. It could be limited to aircraft emissions while operational, or it could involve the entire product life-cycle – from manufacture to decommissioning. The 2.5% figure likely does not address other airport-related activities, including ground transportation by travelers and employees.

The above quote makes a case for changes in aircraft technology (likely as a cost-savings for airlines), which will have a secondary benefit of addressing environmental concerns. These remain speculative projections at this point, but advances in hybrid and electromotive propulsion hold the promise to reduce noise and air pollution.

Beyond aircraft technology, there are promising trends in market acceptance of automobiles and light trucks with hybrid and fully-electric engines. This helps reduce tailpipe emissions but also shifts

some energy-generation burdens to the power grid (for electric vehicle recharging). Simpler and more cost-effective measures are those that promote developments that encourage walkability, biking, and transit use – something that is happening across the region and the U.S. The Port of Seattle is taking steps to address environmental concerns – replacing old high-mast lighting with high-efficiency LEDs, use of more hybrid and electric vehicles, and development of the Sustainable Airport Master Plan. But the 2020 study will not address – and was not asked to address – any potential climate change effects associated with operations at Seattle-Tacoma International Airport. This is an issue that is worthy of a separate investigation and study.

W. THE FUTURE

The 2020 study has noted future potentials that may affect the study area, King County, and the region. But these future potentials are speculative at best. Not only is there no guarantee that any of these future potentials will be viable, there are likely many more unknown innovations that could affect the study area.

For example, during the 1997 study there was no realistic prediction of innovations like smartphones, on-demand car services (other than conventional taxis), social media, etc. Even light rail access to Seattle-Tacoma International Airport was just a proposal. By 2020, all these unknown "futures" had become part of daily routine and have changed the way we live, work and play.

There are some technological innovations on the horizon, but no one in 2020 can accurately predict how, when or even if they will become a reality. These include such concepts as:

- Autonomous vehicles and connected cars (currently being tested worldwide in numerous cities)
- Flying cars and taxis (to be tested in several cities worldwide by 2023)
- Advanced aircraft engines that rely on alternative energy sources or hybrid engines
- Short Take-Off and Landing (STOL) and Vertical Take-Off and Landing (VTOL) aircraft for large-scale passenger and cargo service
- Hyperloop and below-grade high-speed tunnel systems (proof-of-concept currently being tested).

Advances in telecommunication technology – specifically 5G cellular service – promise to deliver fiber optic cable speeds wirelessly. In 2020, the nationwide 5G network is being constructed by various service providers, soon to be followed by a variety of 5G-capable devices. Proponents of 5G tout its ability to allow people to office anywhere, which could have some effect on commuting and air travel patterns, but there are no examples to-date of widespread applications that are changing our daily lives in such a fashion.

The new 5G service will also introduce a new generation of connected devices that create IoT – the "Internet of Things". Projections vary on how many connected devices are in service in 2020 (smartphones, computers, tablets, smart televisions, digital assistants, etc.), but the numbers exceed the global population. By 2030, these devices are expected to increase exponentially to perhaps 30 billion or more worldwide. The deployment of billions of new connected devices and vehicles may have some influence on travel and commuting, but their effects remain hypothetical at present. The 2020 study recommends policy decisions and capital expenditures remain flexible enough to accommodate these as-yet unknown changes to the future.

The COVID-19 coronavirus pandemic during the last few months of the 2020 study impacted every aspect of daily life and economy globally. It forced the immediate pivot of retail, work and school to online platforms and working from home. Evidence of these changes was visible in dramatic reductions in travel patterns – from nearly empty highways to far fewer air passengers. Time will tell how these changes are manifest over time, but there is the potential that COVID-19 may have inexorably changed the nature of some travel habits.

New airport

The Seattle metropolitan area is currently served by three airports – Seattle-Tacoma International Airport, Paine Field, and Boeing Field (the latter provides commercial charter service). Discussion of a potential fourth airport has been ongoing for 26 years:

- In 1994, the Puget Sound Regional Council studied the potential for a new airport at several locations, all of which received significant opposition. The 1994 study ended with no further action.
- In 2005, Alaska Airlines and Southwest Airlines proposed using nearby Boeing Field, which was rejected by King County. (In addition to Seattle-Tacoma International Airport, Alaska Airlines now provides passenger service from Paine Field in Everett.)
- In 2019, Gov. Jay Inslee signed a bill sponsored by State Sen. Karen Keiser (Des Moines) to create a commission tasked with locating a new airport. The commission will identify six candidate locations by January 2021, with a preferred site being located by January 2022.

Developing a brand-new ground-up airport is a lengthy and complex process – the most recent completely new U.S. airport was Denver International Airport (DIA) which opened in February 1995 after 15 years of study, design, review and construction. Should the state of Washington identify a preferred location for a new airport by 2022, that airport might not be operational until at least 2037.

The Port of Seattle is also expanding airport facilities by an additional 19 gates to address increasing passenger demand. But in November 2019, Alaska Airlines – one of the primary carriers at Seattle-Tacoma International Airport – voiced its opposition to this expansion effort, citing issues with security clearance, passenger convenience, and increased congestion. Alaska Airlines contended that Seattle-Tacoma International Airport "is not on land big enough to sustain the expansion for a major airport" and cited Dallas/Fort Worth International Airport and Denver International Airport as examples. Seattle-Tacoma International Airport's expansion appears to be moving forward in spite of this opposition.

The 2020 study does not discourage the investigation of a potential new airport, nor does it discourage facility improvements at the existing Seattle-Tacoma International Airport. A new airport is an attractive future potential, but it does not address immediate concerns and effects in the study area. The 2020 study promotes the new airport study while concurrently addressing the needs and concerns of the study area communities.

X. IN CLOSING

Seattle-Tacoma International Airport is one of the busiest airports in the U.S., and it is important to the economic health of the Seattle region and the state of Washington. The airport and the surrounding study area have grown up together in South King County for more than 75 years – their past, present, and futures are inextricably linked.

Change has been the one constant in South King County and the region. Portions of the study area cities are much more urbanized in 2020 than they were years earlier. When the 1997 study was prepared, it could not predict the rise of innovations like smartphones, social media, or app-driven car services. Twenty-three years later, much has changed that is now part of everyday life. Even something as basic as light rail was only a proposal in 1997 – but in 2020, it is an important link in accessing Seattle-Tacoma International Airport. And while the airport has continued to grow, the pace of that growth has accelerated since 2000, eclipsing the pace of growth locally and regionally.

The 2020 study was to assess effects related to aviation activity in the study area as a means to help address future effects as Seattle-Tacoma International Airport grew. However, there is no single metric – no "experience index" – to accurately incorporate all concerns into a single metric.

The 2020 study has determined that **noise** has been the primary issue during the study period (1997 to the present). **Air quality** and its associated possible effects on **public health** were also a concern, especially from some residents of the study area. Both noise and air quality concerns are not uncommon issues for areas close to airports in other cities. They can also affect aspects of the study area, including effects on the environment, human health, student learning, and the economy. The further definition of airborne particulate matter – specifically UFPs – merits further study to determine any epidemiological effects. The 2020 study does not have the data or local sampling evidence to reach a conclusion regarding UFP effects in the study area.

If the changes from 1997 to 2020 were unanticipated, the next 23 years – by 2043 – could bring new innovations that are beyond our present imagination, including new modes of travel, new means of aircraft propulsion, and new technologies that change how we live, work, play and travel.

As enticing as the future is, there are concerns that face the study area cities in 2020. As an important component in the region's economy, Seattle-Tacoma International Airport should also strive to minimize effects from its operation so that the residents of Burien, Des Moines, Federal Way, Normandy Park, SeaTac, and Tukwila do not bear an undue burden, whether from noise, air quality, traffic congestions, or other effects.

A well-known aphorism often attributed to President John F. Kennedy states that "a rising tide lifts all boats." It is recommended that this be a guiding principle in the further development and operation of Seattle-Tacoma International Airport as it continues to grow. What benefits the airport should have an associated benefit to the surrounding study area cities. And by extension, operations at the airport should not negatively affect its neighbors.

Y. APPENDICES

This report is supplemented by the following six appendices (separate document):

https://deptofcommerce.box.com/s/vlw1drlw7cp6upgxsh3koe1diwh1dfo7

- **Appendix A – Detailed Study Report**
  Section 1 – Introduction.
  Section 2 – Historical background of the study area.
  Section 3 – Case studies of three comparable airports.
  Section 4 – Summary of public and community input.
  Section 5 – Summary of noise and vibration evaluation and analysis.
  Section 6 – Summary of air quality evaluation and analysis.
  Section 7 – Summary of mobility evaluation and analysis.
  Section 8 – Summary of surface water quality evaluation and analysis.
  Section 9 – Summary of groundwater and soil quality evaluation and analysis.
  Section 10 – Summary of light evaluation and analysis.
  Section 11 – Summary of public safety evaluation and analysis.
  Section 12– Summary of public health evaluation and analysis.
  Section 13 – Summary of socio-economic evaluation and analysis.
  Section 14 – Summary of study findings.
- **Appendix B – References**
  A listing of technical references used in the 2020 study.
- **Appendix C – Stakeholder Interviews**
  A summary of all stakeholder interviews.
- **Appendix D – Project Contacts**
  A listing of people involved in the 2020 study, including attendees at the public workshops.
- **Appendix E – Glossary**
  A listing of technical terms used in the 2020 study.
- **Appendix F – Other Reports**
  Additional information provided.

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Bethel Public Schools Resolution 15 (22-23): A Resolution of the Board of Directors, Bethel School District #403, to Certify that the Board of Directors Opposes the Construction of an Airport in the Bethel School District Area (E.S.)

Resolution No. R2023-12s: A Resolution of the Pierce County Council Objecting to the Siting of a New Airport at Any Greenfield Site in Pierce County; Requesting the Commercial Aviation Coordinating Commission (CACC) to Exclude Greenfield Sites in Pierce County from Its Final Preferred Location Recommendation for an Airport; and Requesting the Washington State Legislature Take Specific Actions (E.S.)

Bethel Public Schools

RESOLUTION 15 (22-23)

A RESOLUTION OF THE BOARD OF DIRECTORS, BETHEL SCHOOL DISTRICT #403, TO CERTIFY THAT THE BOARD OF DIRECTORS OPPOSES THE CONSTRUCTION OF AN AIRPORT IN THE BETHEL SCHOOL DISTRICT AREA.

WHEREAS, Bethel School District #403, Pierce County, Washington, operates 29 schools for 20,000 students in 202 square miles of Pierce County and at least four of these schools are in proximity to the possible locations for a new regional airport in Pierce County, and

WHEREAS, the District has great concerns related to the impact of a new regional airport to include safety, noise pollution, air pollution, degradation of the natural environment and scenery, increased traffic that will detract from our ability to transport our 10,500 students that rely upon daily school bus transportation especially in consideration of the already marginal transportation network that currently exists in the area, (and as reflected by the current Washington State Department of Transportation's study of the Intermodal (surface) Transportation capabilities of this part of Pierce County).

AND, WHEREAS, considering that Pierce County has recently changed zoning housing densities to significantly increase the number of people who will soon be living in this area, and, therefore, increase traffic congestion and other related problems.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of Bethel School District #403, its opposition to the construction of a new regional airport in the portion of Pierce County in which Bethel School District is located.

The foregoing resolution was adopted in an open, public session at a regular meeting of the board of directors of Bethel School District held this 24th day of January 2023; the following members present and voting:

Board of Directors:

Bethel SCHOOLS

_____
Brenda L. Rogers, President

_____
Marcus Young, Sr., Vice President

_____
Terrance Mayers, Sr., Director

_____
Roseanna Camacho, Director

ATTEST:

_____
Secretary to the Board

_____
John L. Manning, Director

Sponsored by: Councilmembers Amy Cruver, Marty Campbell, Paul Herrera, Ryan Mello, and Dave Morell
Requested by: County Council

RESOLUTION NO. R2023-12s

A Resolution of the Pierce County Council Objecting to the Siting of a New Airport at Any Greenfield Site in Pierce County; Requesting the Commercial Aviation Coordinating Commission (CACC) to Exclude Greenfield Sites in Pierce County from Its Final Preferred Location Recommendation for an Airport; and Requesting the Washington State Legislature Take Specific Actions.

Whereas, in 2019, the Washington State Legislature passed Senate Bill 5370, creating a Commercial Aviation Coordinating Commission (CACC), which was tasked to identify and recommend a location for a new primary commercial aviation facility (airport); and

Whereas, the mission of the CACC was constrained due to limited funding and the pandemic outbreak, which constrained its ability to provide suitable public outreach, and to examine air space constraints and built environments; and

Whereas, the preliminary recommendation of the CACC short-listed two greenfield sites in Pierce County as potential locations for a new primary commercial aviation airport; and

Whereas, in October 2022, Pierce County leaders sent a letter to the CACC strongly objecting to inclusion of either greenfield site in the CACC short-list of potential locations for a new commercial aviation airport; and

Whereas, the Pierce County greenfield sites are outside of the Urban Growth Area on rural undeveloped land and lack the necessary infrastructure to support a commercial aviation airport; and

Whereas, a commercial aviation airport on either greenfield site poses significant risk to ground water and aquifer recharge, may adversely affect surface water and watershed health, and may endanger habitat for salmon and other critical species; and

Whereas, a commercial aviation airport on either greenfield site also poses risks of significant air and noise pollution; and

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Tacoma, WA 98402

Whereas, a commercial aviation airport on either greenfield site will adversely affect existing rural communities and rural character and may threaten generational investments in schools, businesses, and other community assets; and

Whereas, the Nisqually, Puyallup, and Squaxin Island Indian Tribes have expressed strong objections to the siting of a major commercial aviation airport on the greenfield sites; and

Whereas, emergency service providers have also expressed concerns regarding the impact that a commercial aviation airport within the rural area would have on the providers' ability to respond to emergency calls; and

Whereas, a commercial aviation airport at either of the greenfield locations could also adversely interfere with Joint Base Lewis-McChord, a military installation that is essential to the national defense and critical to the regional and state economies; and

Whereas, additional consideration must be given to integrating new technologies and expanding current facilities for the purpose of meeting future air cargo and air passenger capacity needs; and

Whereas, the Pierce County Council has reviewed information provided by the CACC, received input from residents, industry, and community leaders and has determined that siting a commercial aviation airport at either of the two identified greenfield sites would negatively impact the health, safety, welfare, and quality of life of the citizens, residents, work force, and all who desire to live, work and recreate in Pierce County, Washington; and

Whereas, HB 1791, sponsored by Representatives Fey and Dent, relating to studying the need for increased commercial aviation services, was introduced in the 2023 Regular Session on February 6, 2023; and

Whereas, HB 1791 restarts and reorganizes the Commercial Aviation Coordinating Committee (CACC) process under a new name, the Commercial Aviation Coordinating work group, and establishes new timelines, membership and focus on concerns expressed by this Resolution; and

Whereas, the proposed work group will address aviation needs in the context of overall state transportation needs over the next 20 years; and

Whereas, the proposed work group will be composed of 29 members to include representatives from the state House and Senate, airline, cargo, aviation and airport-oriented entities, metropolitan planning associations and citizen representatives with at least two coming from statewide environmental organizations and citizens representing communities that are included in the work group's site research; and

Whereas, the proposed work group will consider both new greenfield sites and previously identified sites as well as expansion of current airports; and

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Whereas, sites will be evaluated for impacts on community members, quality of life, environmental impacts, weather patterns, alignment with county master plans and other local planning and zoning, as well as airspace operations; and

Whereas, the work group will work with government actors such as the Federal Aviation Administration, the Environmental Protection Agency, Department of Energy, Indian Tribes, local communities, and economic development agencies; and

Whereas, the work group will look at important topics such as weather patterns, terrain, airspace restrictions, costs of construction and site infrastructure needs including access to aircraft fuel; and

Whereas, the work group is barred from considering the expansion or siting of an airport incompatible with military operations; and

Whereas, the work group will report annually to the Transportation Committee of the legislature starting in 2024 but has no deadline that might lead to incomplete consideration of important matters; **Now, Therefore,**

BE IT RESOLVED by the Council of Pierce County:

Section 1. The Pierce County Council affirms its objections to the siting of a commercial aviation airport at greenfield sites in Pierce County as stated in Pierce County's October 11, 2022, letter to the Commercial Aviation Coordinating Commission (CACC).

Section 2. The Pierce County Council requests the CACC and any successor work group not include any currently identified greenfield sites in Pierce County as the CACC's final preferred commercial aviation airport location recommendation to the Washington State Legislature.

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Section 3. The Pierce County Council respectfully requests the Washington State Legislature take the following actions:

- Adopt legislation substantially similar to HB 1791 (2023) as proposed by Representative Fey and Dent, et al.

- Disregard the final recommendation of the CACC should it include a Pierce County greenfield site;

- Require a finding of air space adequacy for any recommended site following consultation with the Federal Aviation Administration;

- Require all recommended sites include assessments of the infrastructure and transportation systems necessary to accommodate a commercial aviation airport along with estimated costs of addressing infrastructure and transportation system deficiencies; and

- Require all recommended sites undergo further assessment of potential impacts to the natural and built environment to include, but not be limited to, further assessment of ground and surface water quality impacts, air quality impacts, noise and lighting impacts, impacts to the habitat of salmon and other critical species, impacts to transportation systems, and impacts to emergency responders and emergency response times.

ADOPTED this _____ day of _____, 2023.

ATTEST:

PIERCE COUNTY COUNCIL
Pierce County, Washington

_____
Denise D. Johnson
Clerk to the Council

_____
Ryan N. Mello
Council Chair

Pierce County Council
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We appreciate the public outreach work that the Port and FAA have done over the years—the regular communication with communities has built a solid base for issuance of the Draft Environmental Assessment and the public's review. It would be a shame for that outreach and engagement to cease now, precisely when members of the public have a specific need for more time. A short 35-day extension will provide a greater opportunity for full and meaningful public participation.

Thank you for considering this request for a 35-day extension of time until January 9, 2025.

Sincerely,

Kristen L. Boyles
Managing Attorney, NW Regional Office

cc: Mia Ayala-Marshall, DRCC Clean Air Program Manager

Defenders of Highline Forest Community Forest Consensus (Defenders of Highline Forest)

Defenders of Highline Forest

COMMUNITY FOREST CONSENSUS

As of December 2024, 3,760 community members, including 16 elected officials and 61 organizations and businesses, have signed the Community Forest Consensus. See public signers and read their comments at DefendersofHighlineForest.org

CALLING FOR EMERGENCY ACTION AND LONG-TERM SOLUTIONS BY OUR ELECTED OFFICIALS TO DEFEND THE HEALTH OF PEOPLE IN THE NORTH SEATAC PARK COMMUNITY AND WITHIN TEN MILES OF SEATAC INTERNATIONAL AIRPORT AS WELL AS THE STABILILTY OF OUR CLIMATE BY PROTECTING THIS COMUNITY'S GUARDIAN FORESTS, WATERWAYS, PARKLANDS, AND TREES

In order to defend the people in the community surrounding North SeaTac Park, and all who live within the ten-mile community surrounding this airport, from the negative health and climate impacts posed by near-term plans for extensive deforestation and green space destruction by the Port of Seattle, the current owner and assigned steward of North SeaTac Park,

… We Call for:

ONE

Legally-binding securement of North SeaTac Park as a Park in Perpetuity with a permanent prohibition, within the park, to commercial development and tree removal. This may be accomplished by changes in zoning and law, by conservation easement, by transfer or sale of this park land to an appropriate governmental entity, or by a combination of these or other means.

The Port caused the removal by eminent domain of thousands of residents, along with their homes and schools, from the land that this park now occupies. The Port has acknowledged that the creation of the park was "the culmination of a long term and very open planning process to compensate the area's residents for cumulative airport impacts." (1) This measure would honor that expressed intent of the Port.

TWO

An immediate moratorium on tree removal and green space destruction on public lands by the Port of Seattle within 2 miles of SeaTac International Airport with exceptions only for targeted measures to protect public safety or the health of the surrounding natural ecosystem, or to prevent substantial physical damage to existing private or public property, where these objectives cannot be reasonably achieved through other means.

This call for action responds to the recommendation of Public Health - Seattle & King County (PHS&KC) to increase green space and tree coverage, particularly coniferous trees, within ten miles of SeaTac International Airport in order to reduce human exposure to airport-generated pollutants known to cause disease and shorten lives. PHS&KC has found that, with severity increasing as proximity to the airport increases, lifespans in this area are between 1.7 and 5 years shorter than in the balance of the county; premature births, low birthweights, and childhood learning problems are more common; and rates of cancer and heart, respiratory, cardiovascular, and other diseases are significantly higher. (2)

Furthermore, this call is put forth to safeguard human health in a community where residents experience high levels of environmental health disparities as measured by the Washington State Department of Health. (3)

It holds the Port of Seattle and our greater community accountable to the principles of environmental justice under Presidential Executive Order 12898 as well as to US Department of Transportation Order 5610.2 which requires that activities that will have “a disproportionately high and adverse effect on minority populations or low-income populations” must be avoided or mitigated when practicable. (4, 5) As reported by PHS&KC, “the majority of people in King County identifying as Black/African American, Hispanic/Latino, and Native Hawaiian/Pacific Islander live in communities within 10 miles of the airport”, “a greater proportion of people in these communities are immigrants, and a slightly higher proportion are children,” and the percentage of people in near poverty or poverty increased the closer you are to the airport”, ranging from 37.2% - 24.4% within ten miles of the airport as compared with 16.1% in the balance of the county. These poverty rates are even higher for children. (2)

This moratorium must go into effect immediately in order to prevent the Port of Seattle from implementing its current near term plans that would result in significant reduction of green space and tree coverage in this community, and must continue until the CARE Plan for the Greater North SeaTac Park Community, as outlined below, or a plan with comparable protections for our community’s health and our climate-stabilizing urban forest, is in place.

THREE

A plan for Comprehensive Action to Restore the Ecology of North SeaTac Park and Community (CARE Plan), by the Port of Seattle and other partnering jurisdictions, that is fully funded and professionally managed, in order to restore and maintain for future generations the natural areas within and surrounding North SeaTac Park, including forests and waterways, with emphasis on Tub Lake and its prehistoric peat bog, a type of wetland that is highly environmentally sensitive and increasingly rare in King County.

The plan must include control of invasive weeds and preparation for existing and expected climate impacts such as drought, high heat, and pests.

It must, in a manner and at a scale recommended by experts in urban forestry and public health, propose specific steps to implement the recommendation made by Public Health - Seattle & King County to increase green space and tree coverage, particularly coniferous trees, near SeaTac Airport in order to reduce residents' exposure to toxics from airport operations. (3)

It must protect and retain existing trees, as large-diameter trees can capture more toxic particulates, store "disproportionally massive amounts of carbon," and "fulfill a variety of unique ecological roles such as increasing drought-tolerance, reducing flooding from intense precipitation events, altering fire behavior, redistributing soil water, and acting as focal centers of mycorrhizal communication and resource sharing networks." (6)

It should set a goal of restoring urban tree canopy coverage in this community from its current low averages, for example, of 21% in SeaTac (25% not including the airport), 30% in Burien, and 29% in Des Moines, to 40% or more, as recommended by Forterra NW in three studies that it prepared for the Port of Seattle Airport Community Ecology Fund. (7-9)

And it must include concrete actions to limit, as reasonably possible, development activities of the Port of Seattle within ten miles of the airport to its existing developed footprint. The Port controls sprawling multi-acre, single-level parking lots as well as other already-paved and underutilized properties, where redevelopment with higher density approaches are possible, feasible, and ecologically sound.

CITATIONS

1. **FAA Compliance Reviews** of Airport Noise Land Use & Financial Operations: SeaTac International Airport, 2016, p. 11. (/https://www.faa.gov/sites/faa.gov/files/airports/airport_compliance/compliance_reviews/seattle-tacoma-international-airport-report.pdf) Accessed 12/6/24) *Note: This document appears on the FAA website without a cover sheet.*

2. **Community Health and Airport Operations Related Noise and Air Pollution**: Report to the Legislature by Seattle-King County Department of Health in Response to

Washington State HOUSE BILL 1109, December 1, 2020 (https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=Community%20Health%20and%20Airport%20Operations%20Related%20Pollution%20Report_c7389ae6-f956-40ef-98a7-f85a4fab1c59.pdf Accessed 12/6/24)

3. **Washington State Department of Health Environmental Health Disparities Map** (https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map Accessed 12/6/24)

4. **U.S. Presidential Executive Order 12898** (https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice Accessed 12/6/24)

5. **US Department of Transportation Order 5610.2** https://www.transportation.gov/transportation-policy/environmental-justice/department-transportation-order-56102aAccessed 12/6/24)

6. **Mildrexler DJ, Berner LT, Law BE, Birdsey RA and Moomaw WR (2020)** Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest. Front. For. Glob. Change 3:594274. doi: 10.3389/ffgc.2020.594274 (Accessed 12/6/24)

7. **Green SeaTac Urban Forest Enhancement Guide**, Forterra, City of SeaTac, Port of Seattle, 2019. Tree canopy cover for the City of SeaTac estimated at 21% for the entire city and 25% not including the airport, (p. 14). (https://drive.google.com/file/d/1NKfENywJPy52ZTpVgnnvC_SuHvbk9__h/view)

8. **Green Burien Partnership Urban Forest Stewardship Guide**, Forterra, City of Burien, Port of Seattle, 2019. Tree canopy cover for the City of Burien estimated at 30% on p. 10. (https://drive.google.com/file/d/1cl4gsPP_Ic4C2NkLJR5UFwj4oae-a-43/view)

9. **Green Des Moines Partnership Urban Forest Enhancement Plan**, Forterra, City of Des Moines, Port of Seattle, 2019. Tree canopy cover for the City of Des Moines estimated at 29% on p. 13. (https://forterra.org/wp-content/uploads/2022/01/GC_DesMoines-guide_032621_WEB.pdf Accessed 12/6/24)

10. Seattle Tacoma International Airport Sustainable Airport Master Plan Near Term Projects Environmental Review Process **Scoping Information Documents** prepared by Landrum & Brown Inc. for Port of Seattle, July 2018 (p. 11) (https://www.airportprojects.net/sampntpenvironmentalreview/)

11. **Real Estate Strategic Plan: Port Commission Study Session**, July 26, 2016, p 16-22. (https://meetings.portseattle.org/portmeetings/attachments/2016/2016_07_26_SS_5_supp.pdf Accessed 12/6/24) And Port of Seattle **2020 Real Estate Strategic Plan**, (https://www.portseattle.org/sites/default/files/2021-10/2020_Real_Estate_Strategic_Plan.pdf Accessed 12/6/24) August 2021.

Public Signers

Defenders of Highline Forest
COMMUNITY FOREST CONSENSUS

Submitted to Mr. Steve Rybolt
Port of Seattle, Aviation Environment and Sustainability
as a supplement to the Defenders of North SeaTac Park 12/12/24 comment
on the FAA's National Environmental Policy Act (NEPA) draft Environmental Assessment (EA)
for the SAMP Near-Term Projects (NTPs).

As of December 2024, 3,760 community members have signed the Consensus,
including over 3,200, listed here, who signed publicly.
The full list is available for inspection.

The Consensus calls for 1.) permanent preservation of North SeaTac Park; 2.) a moratorium on removal of forest on public land within 2 miles of SeaTac Airport (except to protect human or ecological health or property) as a measure necessary to prevent the Port of Seattle from implementing its current near-term plans that would result in significant reduction of green space and tree coverage in this community; and 3.) a plan to restore the ecology of North SeaTac Park and surrounding forest.

Elected Officials

Washington State Senator Karen Keiser, 33rd Legislative District	
Washington State Representative Tina Orwall, 33rd Legislative District	
Washington State Representative Mia Gregerson, 33rd Legislative District	I have lived in the shadow of the Sea-tac airport for most of my life. There are four generations of my family that have grown up and live or have lived in the Highline area for decades. This has always been an important issue to me. I'm very happy to finally have the opportunity to sign the petition!
Mayor Mohamed Egal, City of SeaTac	
Deputy Mayor Iris Guzman, City of SeaTac	I support saving our trees and expanding green spaces for our community.
Councilmember Peter Kwon, City of SeaTac	
Councilmember James Lovell, City of SeaTac	
Councilmember Senayet Negusse, City of SeaTac	

Councilmember Jake Simpson, City of SeaTac	
Councilmember Joe Vinson, City of SeaTac	
Councilmember Sarah Moore, City of Burien	I just came home from a walk through North SeaTac Park. There is a cedar grove I stand in that seems to block out the noise and stress I carry with me. But that illusion of peace is so fleeting. Climate change alone is enough to threaten these trees, it is a tragedy to our community if we hasten their demise by developing this green space into more of the parking that will never fill our bottomless demand.
Deputy Mayor Traci Buxton, City of Des Moines	
Councilmember Gene Achziger, City of Des Moines	
Councilmember Yoshiko Grace Matsui, City of Des Moines	
Councilmember Harry Steinmetz, City of Des Moines	
Councilmember Kate Kruller, City of Tukwila	It is essential to all cities and communities that are neighbors bordering SeaTac Airport to protect and preserve what few green spaces and recreational resources we have. Various Port of Seattle Commissioners advocate to keeping the Environment to the fore in their policy and actions. Making an agreement with the Defenders of North SeaTac Park Community Forest in a consensus with community trying to do exactly that work - protecting what little green space and tree canopy there is left surrounding SeaTac Airport would certainly be the very least it could do. Do this for people who crave the outdoor space to see and and exercise in healthy ways. Do it for our children and generations to come. Do it for what little wildlife that thrives there. Do it for the air we breathe. Do it because we don't need expansion; we need the airport to continue finding ways to curtail its already enormous pollution levels. Do it because the airport needs to work to a strategy on how to fit into the communities that have surrounded it and accepted it for decades, to protect the last sustainable green space that community holds in high regard to allow us all to flourish.

Organizations and Businesses

350 Seattle	Seattle	https://350seattle.org/
ACLU Burien People Power	Burien	https://www.facebook.com/BurienPeoplePower/
Alimentando al Pueblo	Burien	https://alimentandoalpueblo.org/
Allison Ostrer, Certified Spanish Interpreter	Seattle	
Back Alley Honey, LLC	Seattle	North SeaTac Park is an important recreation site as well as native bee habitat worth preserving
Back 10 Rugby, LLC	Fort Wayne, IN	https://www.facebook.com/people/Back-10-Rugby/100086772206039/

Beacon Hill Council	Seattle	https://www.beaconhillcouncilseattle.org/
Boulevard Park Community Action Network		
Breakfast Racing Team	Seattle	https://www.facebook.com/breakfastcyclingclub/
Cascadia Climate Action	Seattle	https://cascadiaclimateaction.org/
Cascadia Forest Therapy	Burien	https://cascadiaforesttherapy.com/
Clark County Chiefs Rugby Club	Vancouver	Rugby plays a large role in giving youth and adults a safe outlet to express themselves and continue playing in a competitive sport. Through rugby we have taught youth and adults respect, courage, how to overcome adversity, and to freely express themselves in a safe and caring environment. It is becoming more challenging to find space to play this incredible sport and Pat Ryan field is used by a magnitude of youth and adult teams in the greater Seattle area. Without it who knows where these teams go and will the rich history of rugby in the greater seattle area decline or disappear?
Climate Action Group at Seattle Insight Meditation Society	Seattle	For climate justice this area needs to be protected from airport expansion and continue to be green space and tree canopy for surrounding neighborhoods. https://seattleinsight.org/engaged-buddhism/climate-action-group/
Community Visions	Burien	https://www.facebook.com/CommunityVisionsBurien/
Deschutes Rugby Club	Lacey	https://www.deschutesrugby.com/
Duwamish Valley Neighborhood Preservation	Tukwila	https://anthropocenealliance.org/duwamish-valley-neighborhood-preservation-coalition/
Environment, Energy and Land Use Caucus of the	33rd and 34th Legislative Districts	
Evergreen Mountain Bike Alliance	North Bend	https://www.evergreenmtb.org/
Extinction Rebellion Seattle	Seattle	https://xrseattle.org
Foodish Solutions, LLC	Seattle	https://foodishsolutions.com/
Friends of Lincoln Park	Seattle	https://friendsoflincolnpark.blogspot.com/
Friends of Seattle's Urban Forests	Seattle	Protecting trees and parkland is vital to keeping communities and their residents healthy. Please give permanent protection to North SeaTAC Park. https://friends.urbanforests.org/
Habitat Restoration Specialists, LLC	SeaTac	https://www.habrespclst.com/
Highline Education Association	Tukwila	https://www.highlineea.org/
Insight Consulting Services, LLC	Renton	https://www.insightconsulting.net/
Kent Crusaders Rugby Club	Kent	https://www.facebook.com/KentCrusadersRugby/ We need to keep places for kids to play all sports. If we continue to take away fields our kids will not be active. We need to allow this generation to grow.
Kitsap Rugby Club	Bremerton	https://www.kitsaprugby.com/

Liberty Rugby Club	Renton	https://libertyrugby.org/home/ Being the current Head Coach and former player of the Liberty Rugby Club, I can confidently say that Pat Ryan has been a staple in my life. Pat Ryan has brought more memories than possibly any other place in this world. I am not the only one. Thousands of games with hundreds of clubs have played on this field. It's more than just a rugby field, it's a location that creates community. Community is what we need more than ever in today's world and removing Pat Ryan Field would diminish that. This field is much more important than one may realize. Colton Jensen, Head Coach Our club has utilized Pat Ryan as a rugby pitch since before I became a board member in 2016. We service many individual youths from Seattle to Maple Valley and we do not let the ability to not pay get in the way. Our season is filled with fundraising to scholarship kids for the chance to be part of our Liberty Rugby family. Our sport reaches beyond our PNW area with a recent tour to Spokane for 100 of our kids. This field is our home pitch and without it we would be forced into high school and middle school fields that are already heavily overbooked with other sports. There are zero dedicated rugby fields with proper uprights in our region. We are a community with big hearts and this loss would be immeasurable. We invite port of Seattle representatives to our Club Day events on April 15th and 22nd to see what we are all about. We will feed you as this is part of our rugby culture. We will be at Pat Ryan from sun up to sun down, please join us! (You can find us on Facebook) Amy McGann, Board Member
Manifest Futures	Kent	https://www.manifutures.com/
Matilda Doula Services	Burien	https://www.matildadoula.com/
McDowell Northwest, Inc.	Kent	https://mcdowellnw.com/

MyAudioVideo.com	Sumner	https://myaudiovideo.com/ We all know you can't stop growth, however this SeaTac park area is the very definition of growth. First, there is no questioning the need for carbon reduction, and trees, shrubs, grass do a very good job of this, not to mention the oxygen outtake which humans and animals seem to enjoy. Second, to see young kids NOT on their phones, NOT in front of a TV, NOT on a street corner, but rather playing or riding their bike in a forest and grinning from ear to ear is not only incredibly healthy for them, but this has a substantial trickle out benefit to society as here is one less depressed young person reaching for drugs or alcohol...or a gun. We talk of solutions we need to enact in our world, right now, to solve the planet climate issue, the mental health issues, the healthcare issues, the crime issues, yet, in one fell swoop, by leaving this Park alone, I submit, that without spending a dime, we just found solutions across the board. Please, leave it alone. The planet thanks you. The wildlife thanks you. The kids thank you. I thank you. Ryan
Nimbusnet	Redmond	https://nimbusnet.com/
Northwest Animal Rights Network	Seattle	https://narn.org/
Northwest Kidney Centers	SeaTac	As a neighbor to North SeaTac Park, we are fortunate to realize the benefits of this green space. Not only is it a place that our staff enjoy throughout the year, but it provides a serene backdrop that promotes healing for our patients. Our clinic windows open up to the park so our patients who spend up to 12 hours a week in our clinic can enjoy the view. nwkidney.org
Off Camber Productions	Sammamish	https://offcamber.bike/
Panthers Youth Rugby Club	Redmond	https://www.facebook.com/panthersyouthrugby/
People for Climate Action	Groups in 14 King County cities,	https://peopleforclimateaction.org/
PURE Juicer Co	Seattle and Burien	Please do your part to support and PRIORITIZE the surrounding communities, the park ecosystem and the families of SeaTac, Tukwila, Burien and North Highline. https://purejuicer.com/
Quiet Skies Puget Sound	Des Moines	http://quietskiespugetsound.org/
R&R Home Improvements, LLC	Spokane	During my time living in Tukwila I came to love this field. This field is very important to the rugby community and provides a great opportunity for kids to have a healthy outlet. This field is one of the most unique fields in the area and I would hate to see it go.
Rugby Washington	Covington	https://rugbywa.org/
Saltwater UU Church Climate Action Now!	Des Moines	https://saltwaterchurch.org
Seattle Cruise Control	Seattle	Preserving the trees is essential, as they provide some respite from the noise and pollution near the airport, and for carbon sequestration. Our goal is reducing damage from cruise ships, so we stand with you in solidarity. https://seattlecruisecontrol.org/

Seattle Rugby	Seattle	https://www.seattle.rugby/ The rugby programs which use this facility; of which there are many, support many including people from underserved communities of youth and adults in the region. These programs also help find employment, provide financial, physical and psychological support for these members of that community. If these teams do not have a place to be then they will not exist and these charitable organizations will no longer exist and thus members of our youth and adult community lose that much needed support. Kevin Flynn, President
Seawolves Rugby	Seattle	https://seawolves.rugby/ Growing the sport of rugby starts with access to venues which is limited in our region to a handful of rugby pitches. Many of the youth that play on Pat Ryan field come from underserved communities and the Port has a responsibility to preserve this park for the community or build an even better facility that is not disruptive to current youth programs.
South Seattle Climate Action Network	South Seattle	http://www.southseattleclimate.org/
South Sound Assassins Rugby	Olympia	https://www.facebook.com/southsoundassassins/
Stable Planet Alliance	Mt. Vernon	Our papers "World Scientists' Warning of a Climate Emergency" (2019 online and 2020 in print) and "World Scientists' Warnings into Action: Local to Global" (2021 online / in print) both emphasized the strenuously avoid cutting mature trees and forests at all scales, from local plots and municipalities to global carbon and biodiversity reserves like the Amazon. As a Western Washington-based global coalition of respected and dynamic organizations collaborating to "bend the curve" on impacts on our planet, using the best and most rigorous science and deep media and public policy, planning and implementation expertise at local, regional and global levels, we strongly ask our colleagues in decision-making capacities to cancel plans to alter the SeaTac Park in any way which would reduce its important biodiversity, carbon, quality of life, air quality, recreation and noise attenuation values for our diverse local communities. Thank you. We are signing both in organizational and individual capacities. https://www.stableplanetalliance.org/
St. Francis of Assisi Parish	Burien	https://www.stfoa.org/welcome
StraightEIGHT Films	Seattle	The intrinsic value and useful, day to day value of this land is exceptional, but only in the form of a park. Please consider protecting and preserving North SeaTac Park for future generations of families, mountain bikers, dog walkers and folks from all over South Seattle, Burien, West Seattle, Des Moines, SeaTac and surrounding communities. This land has a positive impact on so many people. Let's keep it a green, healthy place to recreate and convene. https://www.str8films.com/
Sugarcane Yoga	Burien	https://sugarcaneyoga.com/

Tacoma Rugby Club	Tacoma	https://tacomarugby.com/
The Last 6000, a project of PlantAmnesty	Seattle	In a warming world, urban forests in particular are a survival strategy for adjacent communities. We support the preservation of this forest so it may continue to provide air pollution filtration, stormwater management, urban heat island cooling, wildlife habitat, and a source of joy and beauty for surrounding residents. https://www.thelast6000.org/
TreePAC	Seattle	Help protect the health of airport neighbors by permanently protecting North SEATAC Park and trees and forests surrounding the airport. https://treepac.org/
Utility Squared Community	Seattle	https://utilitysquared.org/
Valley Kangaroo Rugby Football Club	SeaTac	Pat Ryan Field, located at the southern end of North SeaTac Park, is the only dedicated rugby pitch in King County and is a valuable asset to the residents of SeaTac and the greater South King County community. It is home to the Valley Kangaroo Rugby Football Club and its youth program, the Liberty Rugby Club, collectively serving 250 registered boys, girls and adults between the ages of eight to fifty two years old. Club members include those with development disabilities, first and second generation immigrants, those here through refugee programs, veterans, and BIPOC backgrounds. Many of our participants speak a language other than English as a primary language. Many of our players are also lifelong residents of SeaTac and the surrounding community who grew up playing on this field. Rugby is a team-driven, community-based sport that is played by all body types, abilities, and across all ages. It is played internationally and welcomes all participants of all backgrounds and all skill levels. Rugby's culture and values teach respect and support of oneself, one's teammates, one's environment, and one's community, both on and off the pitch. Rugby provides an outlet and a community where one might not exist at home. It provides a means of helping players and their families with social bonds, friendships, and support. It provides an immediate support group and sense of family, community, and inclusivity. Access to organized team recreation is difficult in South King County, especially for low income residents and minority populations. Rugby is no different. Pat Ryan Field benefits the community by lowering the hurdles required to participate in rugby by providing safer, better access, and more opportunities to learn and participate in the sport. Losing this field access will be devastating to those in the rugby community. We urge you to preserve the North SeaTac Park, including Pat Ryan Field, so that we may continue giving back to the community and provide a home for our youth and future generations to enjoy.
Weed Warriors Nature Stewards Program	Burien	https://www.naturestewardswa.org/ Save trees and wildlife habitat for future generations!
West Seattle Bike Connections	Seattle	http://westseattlebikeconnections.org/

West Side Ronins	Renton	https://www.facebook.com/WestsideRonins/ Pat Ryan field means a lot to our community from youth to adults. We hope that it will be protected so future youth and members of our community may enjoy it.
World of Mayhem Motorcycles	Burien	http://www.worldofmayhemmotorcycles.com/

Community Signers

Stephen	Lamphear	Burien	98146	*Mr. Lamphear served as a Burien Councilmember from 1998-2005, and is founder and founding President of the Board of Highline Botanical Garden, which is in North SeaTac Park*
Rose	Clark	Burien	98148	I call upon the Port of Seattle to honor the pledge that was made when they were purchasing homes for the second runway from S 156th north to S 12th from 24th St. to Des Moines Memorial Drive causing the Highline School District to fall from an enrollment of 35,000 to 17,000 roughly. Some of the neighborhoods were left occupied until around the 3rd runway buyout. Our community was decimated. The promise of King County and POS at the time was for a park to be constructed on those formerly residential blocks. For a number of years starting in the 1970s there were fun runs that went by my home on Des Moines Memorial Drive to raise funds for the park. The park reaching south to 156th S was a real commitment the community thought would happen. It is time to make it happen now starting with leaving the trees in place and having community outreach to design the promised park from S 136th to S 156th to complement what the City of SeaTac has built in North SeaTac Park. *(Ms. Clark served as Deputy Mayor of Burien and as a Burien Councilmember during multiple years between 2000 and 2013.)*
Kitty	Milne	Burien	98146	*Ms. Milne served as Mayor of Burien and as a Burien Councilmember during multiple years between the founding of Burien in 1992 and 1999.*
Jordan	Van Voast	Seattle	98144	
Jean	Myers	Seattle	98122	
Carson	Furry	Seattle	98122	
Barry	North	Seattle	98122	
Hadley	Leggett	Seattle	98122	
Dave	Tatro	Port Orchard	98366	
Iris	Antman	Seattle	98118	Green space and tree canopy for impacted front line communities is more important than airport expansion. North SeaTac Park should be maintained as a community greenspace for the health, safety and welfare of the community's residents.

Richard	Harwood	Seattle	98118	
Benton	Coblentz	Tukwila	98188	
Kathleen	Richardson	Burien	98166	Don't grow the Heat Dome: Leave the Trees! Intergovernmental Panel on Climate Change says we have only a few years to turn our ghg emission rates around. It is no time to be paving over ANY PART of this park.
Beth	Brunton	Seattle	98144	
Sandy	Hunt	Seattle	98118	Trees near the airport are needed to clean our air. The community in that area was dissolved because it wasn't safe for people to spend significant amounts of time there. The communities of this area need more parks and open green spaces, not parking lots and warehouses. Protecting trees and growing an urban forest in the communities around the airport is long overdue. Please stop tree removal and forest destruction before it is too late. Stop your staff from plowing forward with outdated actions and obsolete policies that no longer align with the port's vision for racial & social equity and climate justice. SeaTac Airport is a benefit to the region while destroying the health, education, and lives of those in its flight path. When we know better, we must do better! signed: Local Teacher
ANDREW	MATHEWSON	Kent	98031	
Robin	Briggs	Seattle	98112	
Greg	Stinson	Seattle	98118	
Bridgid	Normand	Seattle	98118	
Dick	Burkhart	Seattle	98118	We need to stop all plans for airport expansion. It will become contraction in the long run
Taylor	Atkinson	Burien	98146	For the health of our community and earth, now and for future generations.
Annie	Wise	Burien	98168	
Tascar	Wise	Burien	98168	
Christine	Hawkes	Gig Harbor	98035	The life of trees is paramount to clean air preservation.
Noemie	Maxwell Vassilakis	Burien	98168	This is a simple matter of justice. Trees and green spaces that reduce exposure to deadly airport pollutants should not be removed in massive numbers from communities where people are highly impacted by environmental health disparities largely caused by those airport pollutants.
Annie	Phillips	Burien	98168	
Andrea	O'Ferrall	Seattle	98106	Re-think your mission. We need to move away from focusing on economic growth above other measures of success, well-being and prosperity.
Michael	Oxman	Seattle	98146	Dear Elected Officials, North Sea-Tac was set aside as a natural forested buffer to minimize airport impacts, so please ensure this goal is maintained.

Blythe	Sather	Normandy Park	98166	Save this amazing park!!
JoAnn	Cowan	Normandy Park	98104	Please follow the guideline outlined by this e-mail. It is vitally important to so many people!
Stephanie	Stone	Burien	98168	These trees are critical for breathable air for those of us who live underneath this highway in the sky. This is a family community and all of our children use the park on a daily basis. This should be illegal to continue deforestation in an area so critical with global warming already risking our kids future. Shame on you for making these decisions at our expense and well being just so that you can make a dollar. Make better choices that benefit everyone instead of just yourselves. Think outside the box for more appropriate, greener alternatives.
Ruel	Walker	Burien	98168	I grew up playing football at this park with the Burien Bear Cats. My kids play at this park. Please don't take this away from us. We can't afford to move anywhere else.
Carol	Liedke	SeaTac	98168	By committing to and honoring this statement, the Port of Seattle will be honoring its own mission statement to protect the environment AND protect the residents by establishing firm guidelines (as mentioned) that will serve the community well for decades to come.
Clint	Walker	Burien	98168	My family and I use this park everyday. It is a critical park that this area needs badly. We're all poor in this area which is why we are forced to live under the airport. This park is the ONLY thing that we have. The air quality is bad enough - don't make it worse taking away our trees that clean the air. This park is vital in keeping our young ones healthy and out of trouble with all the gang violence in Burien.
Andrew	Lavadour	Burien	98168	Destroying north SeaTac park is inexcusable. Especially considering the abandoned lots left At the old Laura lake apartment complex. Spend the money and clean that site rather than take the easy road at north SeaTac park
Judith	Williams	SeaTac	98188	
Robert and Rebecca	Rider	SeaTac	98168	
STUART	NIVEN	Seattle		
Debi	Wagner	Burien	98166	Stop destroying our environment
Jennifer	Gould	SeaTac	98168	
Josh	Powers	Seattle	98106	Natural habitats are crucial to any long term goals. Short term benefits of development are quick and easy to create. The long term benefits of these existing biomes need lifetimes to re-establish once destroyed.
Meagan	Lass	SeaTac	98168	
Jean	Trent	Seattle	98115	
Kimberly	Smith	SeaTac	98188	
Laura	Gibbons	Seattle	98118	
Rob	Briggs	Vashon Island	98070	

Laureen	France	Seattle	98199	We must stop destroying green spaces and trees in favor of additional development that pushes us all closer to a climate disaster.
Miranda	Marti	Seattle	98117	
robert	loso	Seattle	98106	not right to evict these homeowners then use their land for other purposes
Nicole	Martin	Seattle	98108	
Luciana	Bosio	SeaTac	98198	
John	Powell	SeaTac	98168	
Darby	DuComb	Seattle	98115	
Randy	McLain	SeaTac	98188	
Amado	Dominguez	SeaTac	98198	we need to save the life of our trees, it's time to react and think that without them we are nothing!!!
Brandon	Kitts	Burien	98146	Trees are the best thing we can foster to negate the detrimental impacts of urbanization. Conserving and expanding green space is a no brainer in a high density area like ours.
Brandon	Dilbeck	SeaTac	98168	We need the city to preserve these parks for our citizens' health and well being. We are fortunate to have so much forest space in our neighborhood, with places for us to exercise and for trees to provide us with oxygen. And where else are the squirrels supposed to live? We mustn't keep destroying nature for our own gain.
Constance	Sidles	Seattle	98105	Dear Port officials, building more parking spaces for cars is not the answer. Encouraging - or even insisting that - people take public transportation to the airport is the only sustainable way to handle ever-increasing air traffic. Paving over a habitat with significant tree canopy for the sake of cars is a recipe for higher air pollution, hotter heat traps, and poorer quality water. You owe the future a better solution.
Sharla	Dodd	Seattle	98103	
Cheryl	Brooks	SeaTac	98188	
Martha	Taylor	Seattle	98115	
Brandon	Bowersox-Johnson	Seattle	98103	Thanks for organizing this! Let's save this green space and create a green buffer around the whole airport to help our community and climate!
Barbara	Lewy	Seattle	98109	The community around SeaTac already pays a heavy price for aviation. Don't add to it!
Jessica	Jones	Tukwila	98168	
Sameth	Mell	Tukwila	98168	
Charlotte	Wells	Port Townsend	99368	People deserve a safe place to live.
David	Feinberg	Burien	98168	
Rosemary	Moore	Mercer Island	98040	
Alex	Fay	Seattle	98103	
Michele	Crocker	SeaTac	98188	Myself and extended family members use this park. Please don't ruin it!

Nadine	Morgan	Tukwila	98188	
Ginele	Lee	Burien	98168	Climate change is here, and affecting our livelihoods. Without environmental protection in place, we will see continued and irreversible damage to our ecosystems and waterways. We are already experiencing the harm of pollutants and removing any trees will just add to our already overworked environment. We are flooding just north of North SeaTac Park due to people and the city allowing developers to clear-cut and destroy our environment. We can not allow the destruction of our precious and scarce treeline. Our future depends on the preservation of what little natural environment we have left here in our small community. Protect our space, and it will protect us and our future generations.
Daniel	Martin	Burien		
Lauren	Herber	Seattle	98126	
Earnest	Thompson	Normandy Park		(Note: Earnest Thompson was serving as a Councilmember for the City of Normandy Park when he signed the Consensus. Sadly, he passed away in August, 2022.) The Port of Seattle has used StART as nothing but a PR scam to use as cover for endless expansion. The endless pollution studies are just a time buying cover to continue building, Even during the Covid pandemic the POS has continued construction. The proof that they are not concerned about health is demonstrated by the fact that they have never discussed how building HYPERLOOP transportation could at the least eliminate the air pollution from jets transporting cargoes. DHL has these projects on-going in 16 countries. HYPERLOOP - No Noise - No Pollution - The Solution! Yes throw us a pittance—- save the forest!
Sophie	Verlaine	Seattle	98118	Please retain the forested park it is beneficial for the immediate neighborhood as well as contributing to the ecosystem by retaining the CO2 exchange particularly so near to the pollution of air traffic. It’s a healthier world when an ecosystem is protected .
Sam	Owens		98144	
Mathew	Irvine	Burien	98166	
Sarah	Hansen	Tacoma	98046	
Dayna	Anderson	Des Moines	98198	
Denise	Sterchi	Seattle	98115	
Aaron	Sheedy	Seattle	98103	Green forested spaces that provide people a place play, enjoy nature, de-compress from the day are increasingly rare in urban environments and should be protected as much as possible. I surely needn't also list the environmental benefits of areas that contain large #'s of tree's regarding carbon capture, better health, etc. Finally, by considering paving over this space, you are contributing directly to increasing inequality by removing this type of environment from a low income area in Seattle. You should be deeply ashamed this even made it past the proposal stage.

Ramsay	Cookman	Burien	98168	
Ilene	Marvin	Tukwila	98168	I support the preservation of the North Seatac Forest.
Jarred	Swalwell	Shoreline	98155	
Andrew	Corman	Renton	98056	
Stephanie	Frantz	Seattle	98126	
Alec	Cervenka	Seattle	98103	
Linnea	Westerlind	Seattle	98136	
Shary	B	Seattle	98101	We need to protect this green space for the health of our environment and all of the people who live in this area.
Selene	Russo	Seattle	98106	
Russell	Poe	Burien	98146	walkable, enjoyable spaces with trees is more important.
Stuart	Jenner	Normandy Park	98166	
Luke	McGuff	Seattle	98107	North SeaTac Forest could easily be a gem of Pacific Northwest urban forest, providing a large tract of native plants and biodiversity. The existing street grid could be turned in promenades and bike paths, providing room for bikers and joggers and people just walking through.
Omaha	Sternberg	Burien	98148	
Dorene	Carrel	Burien	98166	
Isabelle	Heier	SeaTac		
Shambhavi	Taylor	Seattle	98125	
Rebecca	Dare	Auburn	98002	
Donald	Stimson	Newcastle	98059	
DAVID	LARSON	BURIEN	98166	Our community needs refuge from industrial expansion. SEATAC Airport expansion is adverse to health of local communities therefore has a obligation to mitigate these damages by compensation ; financial and in form of green zones.
Lynn	Brittenham	Burien	98168	
Paul	Coblentz	Tukwila		
Deborah	Melchior	SeaTac	98168	
Kathleen	Kresly	Seatac	98188	I love Seatac parks! Keep more green spaces please. I have enjoyed walking my dogs in North Seatac Park and breathing in the big trees for over a decade. Please keep this park for Seatac residents to stay healthy!
Rob	Bent	Seattle	98106	By developing in North SeaTac Park, you act in opposition to your own concrete commitments and with reckless disregard for the health of the people and the valuable natural resources surrounding the airport. Don't betray us!
ANDREW	WRIGHT	SEATTLE	98126	There aren't many places to ride mountain bikes on trails that are accessible without driving. Please preserve this opportunity for our community.

Ellen	Arnstein	Seattle	98102	
Jacob	Moore	SEATAC	98168	The Port should sell this property to the city parks, it should be sold at the original right of way price that it was purchased from the homeowners.
Barbara	McMichael	Des Moines and SeaTac	98198	
Kathy	Kerkof	SEATTLE	98107	I am a senior who grew up on Beacon Hill under the flight path of Boeing and SeaTac Airfields and parallel to the industrial area. My parents had 9 children. Six of us have had various cancers with 2 of us and, also, my mother passing from cancer. The cancer rate is equally as high among other relatives who grew up on Beacon Hill. Industrial pollution is a serious issue, and the health impacts are not to be dismissed. It has been found that people living in the South End have a 10-year shorter lifespan than people living in the North End due to industrial pollution. I am very tired of various local government agencies giving lip service to the issues of racial, social, environmental, and economic justice, promising to address these issues and then pursuing policies that perpetuate the identified injustices. The Port has made a commitment to be "accountable for equitable policies that ensure racial, social, environmental, and economic justice are achieved in strategies, practices, and projects". Please honor that commitment. This park and these trees are vital for the health of the people who live in the near-airport community.
Heather	Alvarez	Seattle	98116	
Johanna	Maloney	Seattle	98106	
Anne	Miller	Seattle	98144	The Port must prioritize the health of the peoples of SeaTac and Washington State.
Elizabeth	Berggren	Seattle	98112	
Rebecca	Stith	Tacoma	98042	Protect North SeaTac Park and surrounding community. Stop deforestation and other environmentally destructive actions proposed as part of the airport’s expansion.
Jodi	Taylor	Burien	98106	
Dee	Selk	Burien	98146	We so need our open spaces and trees to keep our environment clean and fresh. Don't park cars, cut trees, and take our forested area away.
Kersti	Muul	Seattle	98136	
Lisa	Parks	Burien	98166	
D	McCaslin	Seatac	98168	Build you parking garages and ware houses closer to the airport and save the park, trees and fresh air makers. Please when is enough, enough? And at what cost? Humans needs green trees.
AnnaLisa	LAfayette	Seattle	98106	
jazmin	arroyo	Seattle	98168	
Christian	Tinoco	Seattle	98168	
Linda	Roney	Seattle (uninc. K C)	98168	We never got the noise study in north Boulevard Park. It's horrible here!
kristen	michael	SEATTLE	98168	

Lori	Erickson	Burien	98168	
Amanda	Goss	SeaTac	98146	Please keep our green spaces! They are so important to our area in particular.
Caitlin	Tate	Burien	98168	We on Des Moines Memorial Drive have lost so many acres of trees and their diverse ecosystems in the past decade. We cannot afford to lose any more.
Regina	Mutter	Normandy Park	98166	Thank you for thoughtfully considering this consensus statement by our community. This is an opportunity for the SeaTac Airport authorities to not only follow through on the Port's promise to reduce environmental impact to surrounding communities, but also to show leadership in taking steps to mitigate the impacts of climate change as well as provide local citizens access to, and enjoy the health benefits of, green space in close proximity to our neighborhoods.
Marianne	Hudson	Seattle	98146	Please take the necessary steps to protect the plants, animals, and people in this area. Thank you!
Rachel	Hartley	Tukwila	98168	
Rick	Johnson	Des Moines	98198	
Susan	Dedinksky	Des Moines	98198	
Dara	Elish	Seattle	98108	
Angela	Walls	Seattle	98108	We need all the canopy we can get! Save what is there.
Sarah	Wells-Ikeda	Burien	98168	
Rebecca	Cossette	Burien	98168	
Steven	Cossette	Burien	98168	
LANCE	OYLER	tukwila	98168	
Joanne	Nelner	Des Moines	98198	
Ruby	Lamba	Burien	98168	North Sea Tac park was an attractive place for people to walk and walk their dogs. Many people play disc golf over there. There are lots of nice bushes which are giving nice flowers and fruits. Lately it seems city people are cutting all the bushes. Lots of small animals live in the park. I don’t want to loose those animal’s home.
Amanda	Johnson	Burien	98168	
Manuela	Insixiengmay	Seattle	98108	
Shirley	Clough	Burien	98146	
Sheana	Conaway	Bothell	98100	
Martha	Pruitt	Seattle	98108	
Jill	Reese	Seattle	98108	
Harold	Baldwin	Seattle	98108	
John	Carlton	Tacoma	98405	
Maria	Cheha	Seattle	98125	
Stuart	Nielsen	Burien	98168	

Jessica	McComas	Seattle	98108	
Terri	Lindeke	Burien	98148	Our neighborhoods live with the noise and pollution of the airplane all day and all night. Leave the lands that we have transformed to the neighbors who live here.
Heather	Griffin	Seattle	98108	
Susan	Davis	Des Moines	98198	The continued intrusion and destruction of lands adjoining the port surrounding destroys the lives of the community. The trail of broken promises, from the third runway being used “only for emergencies” to now is one example. Now, the Port has begun to whittle away at North SeaTac Park, their gift to SeaTac for not fighting the 3rd runway. A tree here, there, and soon they are all gone. “Safety” always being cited when we all know it is hogwash. We will replant, is a poor answer when it takes 20 years. For a tree to regrow to a decent size. The pact is a good one. It is time to stop lying. Time to stop breaking promises. Sign the pact and live by it. Thank you.
Vicky	Hartley	Burien	98168	
Sewheat	Asfaha	Seattle	98108	
Nicole	Pollock	Burien	98168	This large natural space, free from cars and concrete, is a huge asset to this community. It would be a shame to watch any industry slowly eat it up. And where does all the wildlife go? They need homes too, and are beneficial to the whole ecosystem.
Christina	Coleman	Des Moines	98198	This large natural space, free from cars and concrete, is a huge asset to this community. It would be a shame to watch any industry slowly eat it up. And where does all the wildlife go? They need homes too, and are beneficial to the whole ecosystem.
Michele	Wagoner	Burien	98146	
Brandon	Wysocki	SeaTac	98168	
Bryan	Vinzant	SeaTac	98168	As the years go by this green space will become more and more important while also becoming more desirable to develop. We need to get protection in place or there's no way the green space won't be continually chipped away
Robyn	Winters	Seattle	98168	Our family enjoys this park daily and it brings joy and improves our lives year-round. Our neighborhood and community is a better place for having this park protected and cared for.
Aurora	McKinney	Renton	98057	
Joanna	Oliver	Seattle	98122	
Brianna	Wirkkala	SeaTac	98168	
Kathleen	McManamon	SeaTac	98168	
Krysta	Smith	SeaTac	98188	We need to protect our green spaces as much as possible. Please look at already developed land in order to build your processing facility.
Cristina	Chidhalay	SeaTac	98188	
Natalie	Scantlen	SeaTac	98188	
Sabrina	Cook	SeaTac	98168	

Lynne	Dixon	SeaTac	98188	
Stephanie	Booth	SeaTac	98188	There's already so much pollution in the air from planes, we need these trees to counteract it.
Thomas	Foulds	SeaTac	98188	I use this park as a way to de stress and it’s hard to find fun trails to ride. as someone who has lived my entire life in WA we need to save our green spaces.
Lisa	Jorgensen	Seattle	98168	
Susan	McIlwaine	SeaTac	98198	
Marla	Blazer	SeaTac	98188	
Laura	Kirkland	SeaTac	98198	
Marianne	Jackson	SeaTac	98198	The action we take now for our community will affect generations to come. What kind of a future and legacy will we leave the children? More trees and less development is the only way to go. Since the pandemic began, the overall mental health of our citizens has declined. We need trees and some wild spaces for the wildlife as well. We need to be able to breathe. Please support the environment to help the physical and mental health of our citizens.
Bob	Gruber	SeaTac	98168	I pay a good amount of taxes here and would like the trees to stay. It's bad enough we breath air with spent jet fuel in it. We need these trees, they help contain the noise and pollution from the planes to some extent.
Cristina	Fonseca	SeaTac	98188	
Alejandro	Moreno	Seattle	98168	
Michael	Goebel	Seattle	98166	
Bill	Mills	Tukwila	98168	
David	Hollingsworth	Tukwila	98168	
TaniRae	Standridge	SeaTac	98188	thank you for considering our opinions
Cat	Jiménez	SeaTac	98188	
Richard	Evans	SeaTac	98188	Save our trees.
Ricki	Mudd	SeaTac	98188	
Carrie	Pizzano	SeaTac	98188	Please don’t cut down the trees and put in a parking lot
Margie	Schultz	SeaTac	98168	
Megan	Swarner	SeaTac	98188	
Pamela	Clylde	SeaTac	98188	
Lydia	Ma	SeaTac	98188	
Lisa	Nelson	SeaTac	98188	

Yuri	Rabena	Renton	98159	I support economic growth for the betterment of any city that could provide jobs, stimulate tax dollars and channel that into the community residents. However, there has to be both alternate solutions and a point where the detriment to the neighboring residents is more valuable than the development. The Airport has had a negative reputation with many locals who remember the 3rd runway expansion. And the locals who do live here are again going to be potentially negatively affected again by the razing of a park in the name of development. I find it hypocritical for government agencies to say they're committed to climate change yet as the opportunity exists, perform actions that clearly demonstrate that they don't.
Kenneth	Estes	Seattle		You must be crazy. Back off and remain on your side of US99.
Deborah	Anderson	SeaTac	98188	Dear Port of Seattle, As you know, SeaTac is already a city of parking lots. We need NO MORE. We ask you, hopefully we will not have to demand of you, that you stop now. No increased airplane noise, no increased pollution, NO MORE PARKING LOTS. Leave us this forested acreage to clean the air of the known pollutants that are sprayed over our homes by airplanes daily. This you have the power to do. Please consider us. Please do not ignore your previous agreement to provide this greenspace for SeaTac. This is my city, I have chosen this place. The absolute last thing we need ever is another parking area. We have light rail access to the airport, there are Uber and Lyft services. Our city landscape is already hotels and parking lots. Our only gathering spaces are our two beautiful parks. Please consider the wellbeing of the residents of the city that supports your airport.
Kayleigh	Hickok	SeaTac	98188	Please consider all the benefits the park provides to the community over corporate profits. The park currently contributes to the community identity, provides active and passive recreational opportunities, and appeal to all ages. It also contributes to the health and wellness of a community, creates valuable green space and is beneficial to native plants and animals. Especially in urban areas like SeaTac, parks are an effective area to encourage native flora and fauna to grow.
Maria	Witherow-Starkman	Burien	98168	
Samay	Ferrera	Seattle	98168	
Eric	Enamorado	Burien	98168	
Abigail	Enamorado	Seattle	98168	
Marvin	Enamorado	Seattle	98168	
Kellie	Brinton	SeaTac	98168	I've watched the port of Seattle eat up neighborhoods, forests, communities, filled in lakes, ponds, streams, bulldozing schools, farmlands, nursery's, multigenerational homes ,dumping toxic dirt to build runways under false pretenses ……..like a huge incurable cancer since we moved here in 1958. I am sick of it. I am sick of this entity taking our living spaces, poisoning our grounds, poisoning our very air we breathe to make money for relatively few.
Todd	Cahill	Normandy Park	98166	Please think of the community, and the people you are supposed to be serving.

Terry	Gough	SeaTac	98188	These green spaces are elementally important to the local community as well as the region. They provide places for citizens & visitors to relax, recharge, connect with nature. In addition to that they provide habitat for local wildlife & a natural enviroment to buffer pollution.
Brianna	Johnson	SeaTac	98188	
Thomas	Reiss	Seattle	98107	
Mark	Corier	Tukwila	98168	This green space is vital to the health and well being of our community, its all we have left.
Curt	Fulgham	Seattle	98144	we need MORE WILD not less.
Craig	Thompson	Seattle	98144	In a time of drastic climate change, it is imperative that we preserve the established forest in our region, including park property by SeaTac. The Port has the ability to negotiate with other agencies and businesses for access to runways; please do so.
Jessie	MKenna	Seattle	98144	We need trees! We need THESE trees. Don't develop!
Julie	Fluke	Burien	98166	The port encourages residents to plant trees yet is determined to cut them down for port purposes. How hypocritical can you be?
Liz	Giba	White Center	98146	
Carrie	Campbell	SeaTac	98198	
Alex	Tran	Seattle	98146	
Anjali	Grant	Seattle	98144	Our airports can and should be models to the rest of the country of sustainable development - including compact, low-impact site solutions.
Trisha	Gilmore	Tukwila	98168	The trees in that park make it a livable area, planes and more cars do not!
Holly	Fader	SeaTac	98188	
Jennifer	Johnston	Seattle	98106	
Simon	Gleit	Bellevue	98004	
Shelli	Park	Burien	98166	It is so important to preserve the park, and all of the trees, and thus the health of the neighborhood to the north of the airport.
Rachael	Henton	Tukwila	98188	Deforestation is one of the biggest threats to human health! Children are already suffering from diseases caused by air pollution, and cutting down more trees will only bring more health issues to people in our community. Human health needs to come before profit.
Cathy	Lam	Renton	98057	"Keep the country, country" -a small kine local from Hawaii
Peggy	Bradley	Tukwila	98188	
Sarah	Lasconia	Lake Forest Pk	98155	
Delsie	Baumgardner	Burien	98168	
Toni	Reineke	Seattle	98146	The airport is large enough. WE ALL NEED THIS LAND TO BE PRESERVED INTACT!
Rachel	Wendling	Seattle	98117	

Linda	Halberg	Renton	98058	
Cara	Griswald	Burien	98168	
Angela	O'Malley	Seattle	98168	
Ashley	Busroe	Auburn	97092	
Jacob	Mutter	Burien	98166	The proposed development of the forested area currently known and enjoyed as North Seatac Park is a disservice to the airport community already doing to much in accommodating Seatac airport. Losses to the community in the form of recreational space, ecological buffers, and the health benefits associated with trees as a mechanism for maintaining air quality threatened by air traffic far outweigh any potential benefit from the proposed real estate developments. If the Port is to truly manage growth and sustain the current level of use in an equitable and just way, it must respect and prioritize the needs of the community in which it is operating. The residents are clearly not in favor of the types of developments proposed, and it is time that such options are removed permanently by establishing North Seatac Park as a park in perpetuity.
Tareq	Fayyad	Seattle	98178	The Port needs to honor the needs and rights of residents instead of prioritizing business interests. We have a history full of the latter
Chelsea	Kyger	SeaTac	98168	
George	Gladstone	Seattle	98168	
Charles	Schaefer	Burien	98148	
Ilona	Brose	Burien	98168	
Lily	Luu	Burien	98166	
Tom	Clymer	Burien	98166	This is a fantastic park in an area without many; please don't shrink it for more commercial areas (there are already plenty). Please consider converting existing commercial areas into whatever it is that is needed for your project, and if you can, please convert some existing commercial areas into parks!
Paige	Sandberg	SeaTac	98188	
Graham	Manson	Renton	98056	

Leit	Myers	Burien	98146	it is critically important that parks, open space and green space (particularly green space with tree canopy) be not only preserved as is, but increased for public, community access. the fact that the port would take back green, open space that benefits people's wellbeing in an area where health and economic disparities are greater than in many other areas of King County is really distressing. seatac airport has a negative impact on people's health in this area air, noise and physical displacement, etc.) it's pretty openly disrespectful on the port's part to constantly be on the verge of taking away large portions of one of the few large green spaces in the burien/seatac area to build parking lots, or food service facilities, etc. find another place to take up space, space that is not green space and is not in a community already negatively impacted by port facilities and activities. stop asking this community to bear all the weight of the negative impacts of port activity.
Abigail	Widell	SeaTac	98198	
Eva	Leuthy	Tukwila	98168	
Anahi	Garcia	Burien	98169	
Ella	Frans	Seattle	98168	
Isabella	Castillo Manzo	SeaTac	98168	Don't take our park.
Eunice	Santiago	SeaTac	98168	
Holly	Halter	Burien	98168	
Julian	Lucatero	Burien	98168	
Katie	Gustainis	Burien	98168	
Tara	Jordan	Burien	98168	We said no to the parking lot, which was smaller than your current request. We are not interested in your expansion. We care about our neighborhood, not your financial wants that negatively impact our community quality long term.
Clint	Smith	SeaTac	98168	
Aria	Benner	SeaTac	98168	
Erin	Cote	Burien	98168	
Catherine	Saephanh	Burien	98168	
Wesley	Matlock	Burien	98146	Our green spaces have greater value to the community and our collective health than whatever development would come from destroying them. This park, in its entirety, needs to be protected and the option to develop it removed.
Judith	Williams	SeaTac	98188	
Tracey	Byrne	Seattle	98112	Do the right thing.
Bronsen	Lasconia	Lake Forest Park	98155	
Steven	Cox	SeaTac	98168	Please don't destroy our beautiful habitat. We need it!!
Dennie	Carcelli	Burien	98166	

Neva	Welch	Federal Way	98123	
Steve	Edmiston	Des Moines	98198	
Barbara	Tatham	Burien	98166	
Dean	Tatham	Burien	98168	We love N SeaTac Park!
Molly	Sobba	Seattle	98168	
Robert	Hardy	Burien	98168	
Andrea	Agostinelli	Burien	98166	
Sue	Cook	Burien	98168	You have a responsibility to the neighborhoods surrounding the airport and the greater community. SeaTac Park is not up for grabs. The health and vitality of the community must not be further damaged by Port destruction at SeaTac Park. Keep the promises made to the neighbors and neighborhoods around the airport! And we are watching what you do, not what you say.
Carolyn	Kintner	Burien	98168	Save for recreation. We need trees for airport buffer. We need green space for growing population density. Dow Constantine, King County Executive is looking to increase green spaces due to density. This space is important for recreation. It can be a space for positive youth activities.
Caterina	Bertucci	Burien	98168	
Jolene	Hufty	Burien	98146	
Julie	Thomas	Seattle	98108	
Monica	Optiz	Burien	98146	
Brenda	Rowan	Seattle	98126	Leave our trees alone!
Brian	Lucio	Burien	98168	
Michael	Tangney	SeaTac	98168	
Grace	Whitney	Seattle	98126	
Mike	Herrett	Burien	98146	Please look at using already developed and underutilized land first.
Kelsey	Vanhee	Burien	98168	This green space is so important to me I walk in it daily.
Andreas	Haugen	Seattle	98146	I teach at Cedarhurst elementary school, just a few blocks west of the park. My students and I frequent this park often. I hope that the park can be kept as a public, nature filled space to honor our community and show respect to all its inhabitants.
Anna	Pierce	Normandy Park	98166	It is your duty to act with honor toward the land and our people. Industry will manage - the planet is in your hands.
VIctoria	Carter	Seattle	98146	Please save our trees!
Jeannette	Israelson	Burien	98146	
Amber	Nichol	Normandy Park	98166	Seriously what the f**k. Climate change is happening all around us and you want to *get rid* of one of the few things that people can enjoy before it all burns away? I am bummed that we're stuck with such short sighted and selfish leadership.

Colleen	Curren-Wong	Seattle	98146	We need parks
Pam	Babitsky	Normandy Park	98166	Please leave the parks alone. The tree canopy is diminishing too quickly in King County. The Fir trees that are left are homes for wildlife and are a peaceful part of our landscape. The parks are enjoyed by children and people of all ages (as long as the homeless have not taken them over). Stop the developing of beautiful, natural acreage, we've ruined ruined enough of natural areas. Please keep the park as is for the people to enjoy the natural setting, the trees to provide homes and shelter to birds, squirrels, raccoons and other wildlife. We need to quit destroying natural habitat and the park is essential for the people to get out and enjoy nature. No more cutting down large evergreens and no more developments, asphalt and concrete!! Please leave it alone!
Bethany	Perry	Seattle	98168	
Randy	Perry	Seattle	98168	
Karen	Larson Gordon	Freeland	98249	
Unpublished name		Burien	98168	We need this park and its green tree air cleaning abilities. There is WAY TOO MUCH POLUTION in the air around this area of East Burien and West SeaTac from cars and airplanes. Warehouses and parking can be built underground if no other surface areas exist. This is also a highly-used park by all ages. Surely you can think more creatively about another site.
Unpublished name		SeaTac	98188	Enough greed interfering with our Green Spaces - climate is critical for our future - Please protect what we have
Unpublished name		Seattle	98168	I live North west of the airport. It is imperative that we maintain the area in question as a park. Dow Constantine, King County Executive, recently mandated that green spaces were needed due to the growing population and density of King County. This space has been used recreational by bike enthusiasts, hikers, dog walkers horse back riders and rugby players. The trees are especially needed to buffer the airport and help with pollution. Please do not pave paradise. Thank you.
Unpublished name		Seattle	98117	I voted for 3 newly elected commissioners with the expectation that they'd support N. SeaTac park. I'll be closely watching how the Port protects and enhances N. SeaTac Park.
Unpublished name		Seattle	98168	Please help keep the emerald city emerald for generations to come. Thank you.
Unpublished name		Burien	98166	Please help protect the legacy of this community’s green spaces.
Unpublished name		Burien	98146	Please keep our park protected
Unpublished name		Burien	98166	Please protect our community's green space, thank you!
Unpublished name		SeaTac	98168	Save the trees.
Unpublished name		SeaTac	98188	SeaTac is unique from many other places in that there is a substantial residential population in direct proximity to an international airport. It is our duty as citizens, governments, and organizations to support the wellbeing of that community. This measure promotes that health.

Unpublished name		SeaTac	98188	There will never be enough land for parking, handling facilities etc. , at the end of the day, you'll have to dig deeper and build higher where there is inefficient use of land already. Please start doing it now rather than 10 years down the road and leave the parks in place - once destroyed, this habitat will never come back to what it was.
Unpublished name		Des Moines	98198	Walk the talk and cede this ground to the community, in perpetuity. For the people, for the environment, for the our climate, to show you CAN abide by your commitments rather than roll over them and change for the Port's over reaching wants.
Unpublished name		Seattle	98116	We need clean air and land more than ever before. Any threat to that is a threat to our community.
Unpublished name		Burien	98146	We need more parks and open space in this part of King County, not less.
Unpublished name		Burien	98168	We need this park and its green tree air cleaning abilities. There is WAY TOO MUCH POLUTION in the air around this area of East Burien and West SeaTac from cars and airplanes. Warehouses and parking can be built underground if no other surface areas exist. This is also a highly-used park by all ages. Surely you can think more creatively about another site.
Unpublished name		SeaTac	98168	We need trees.
McKenzie	Cook	Burien	98168	This park is the heart and soul to our community. Removal of this park would have a detrimental impact on the ecology this area provides, in which many plants, trees, and animals thrive and depend on. As a local resident and business owner I ask that you please reconsider this location for your parking lot.
Erin	O'Rourke	Burien	98148	
Tannon	Bird	Seattle	98146	
Erin	Perkins	Burien	98146	
Jana	Buss	Burien	98166	
Barbara	Gagnat McCoy	Seattle	98118	
Ezekiel	Smith	Tacoma	98411	
Unpublished name		Burien	98166	Please keep old promises
Claire	Buxton	Seattle	98118	
Jose	Reyes	Seattle	98108	
Barbara	Trenary	Seattle	98178	There are no reasons whatsoever to but down trees, but a multitude of reasons to encourage growth and plant more of them..
Miranda	Hall	SeaTac	98188	
Mallory	Lux	Burien	98166	This park is a huge part of our community. People of all ages and backgrounds recreate here. Just this week we were using the mountain bike trails and saw a group of young people learning to ride bikes 10-15 people it was awesome! This is a place where people can be outside, play, de stress our community needs that not another parking lot.
Bret	Lux	Burien	98166	

Damon	Vanhee	Burien	98168	
Unpublished name		Burien	98168	Please don’t. And as far as I’m concerned you weren’t even allowed to touch that since it was made for us residents as a place to go to and enjoy with kids and families.
Jacob	DePew	Seattle	98168	Encroaching on north SeaTac park would be catastrophic to our neighborhood. Please let the park be.
Julie	Anderson	Burien	98168	There isn't enough words to express how deeply disappointed I am that after giving the park and the lands to the people around the airport, you are trying to take it back. I understand that building parking structures is more expensive but ultimately it is a better option than trying to take necessary trees and foliage that combats the pollution that is generated by the airport. There isn't nearly enough parks that exist for the families in this area to enjoy and taking this one simply isn't an option.
Lauren	Wood	Burien	98062	
Stuart	Tanasse	Seattle	98106	
Mike	Keller	Seattle	98107	
Daniel	Lim	Seatle	98188	
Maya	Urbina	Maple Valley	98038	Please don’t take our trails, or our trees. they’re more important than I can express with words.
Lindsay	Keithly	Maple Valley	98038	
Lena	Pace	Burien	98168	
Jennifer	Potter	Burien	98168	In a world with less and less green space for children I challenge you to do better and leave this park alone.
Mark	Spencer-Coons	Burien	98168	North SeaTac Park is too much of a natural resource for recreation and quality of life to pave especially given that there are other sites available.
Michael	Manthey	Tacoma	98466	
Melissa	Steppe	Burien	98168	
Samantha	Lim	Burien	98168	
Susan	Thornberg	Seattle	98105	
Tom	Ott	Seattle	98103	
Gwyn	Howard	Seattle	98106	
Damiana	Merryweather	SeaTac	98168	
Greg	Ikeda	Burien	98168	
Katharine	Kaschko	Burien	98166	
Kyle	Terriere	Seattle	98178	
Kyle	Rush	Seattle	98166	
Sé-Alessi	Rowe-Koto	Seattle	98166	
Ivaylo	Ivanov	Redmond	98052	

Maria	Santiago	White Center	98146	
Juliette	Tittel	Seattle	98102	
Natalie	Eagan	Burien	98168	
Tiffany	Hatch	Burien	98168	
Will	Andrews	Seattle	98146	
William	Gordon	Seattle	98108	
Mary	Hill	Burien	98166	
David	Lowry	Seattle	98178	Destroying parks and valuable ecosystems for a parking lots is not okay
Allison	Vasilieff	Normandy Park	98166	
Emily	Neely	Burien	98168	
Dan	Wright	Sammamish	98075	
Katrina	Peters	Burien	98146	
Dylan	Krieger	Seattle	98109	
Rose	Peterson	Lynnwood	98037	
Sebastian	Diaz de Villegas	Seattle	98101	
Kyle	Freed	Seattle	98144	
Kelly	Wales	Burien	98168	
Greg	McLeod	Des Moines	98003	
Unpublished name		Seattle	98108	The proposed change is against the best interests of the community and the local environment.
Stacey	Eck	Sammamish	98075	
Justin	Bales	Seattle	98125	
Brandon	Egbert	Seattle	98108	
Brandon	Stilson	Seattle	98103	
Austin	Omaha	France		I visit Seattle as often as I can, it is one of the USA's top cities for so many reasons. I fly in through SEATAC, and then take the train and busses everywhere I need to go. If Seattle needs another giant parking lot, then the city and SEATAC's port authority have made serious errors in their planning. A type of error that creating more parking spaces won't satiate. Keep working on what matters, saving the parks and expanding public transit.
Seana	Barker	Seattle	98126	This park was created to compensate area residents for airport impacts. The trees in & near it protect residents from airport pollution. PLEASE LEAVE IT ALONE FOR ALL TO ENJOY!
Unpublished name		Burien	98166	Why makes no sense
Ana	Lira	Seattle	98144	

Yoshi	Yagi	Tukwila	98188	
Aviana	Diamond	Seattle	98118	
Bailey	Cheshire	Seattle	98119	
Jonathan	Strannigan	Seattle	98106	Hands off green spaces! We don’t want another parking garage paving over this public asset.
Katherine	Bax	Seattle	98103	
Tara	Brothers	Burien	98166	Please stop trying to take away parks
Paula	Colon	Burien	98166	
Rebecca	Gobeille	Burien	98168	
Karl	Robinson	Mill Creek	98012	
Evan	Derickson	Seattle	98105	
Unpublished name		Des Moines	98198	We need green spaces more than we need parking lots. For Heaven's sake, there's light rail, Uber, Lyft, taxi cabs, and bumming rides off friends and family.
Unpublished name		Seattle	98115	Stop turning our green spaces into pavement. Car-centric infrastructure is a blight on our future, and our children's future.
Matt	Lidlum	Seattle	98103	Please keep our park areas! They're what helps to make this such a beautiful region.
Milo	Hansen	Seattle	98115	
Maxime	Bourgeoise	Seattle	98144	
Cara	Chamberlin	Burien	98168	We've already had this discussion. Build a parking garage and LEAVE OUR PARKS ALONE.
Janelle	Trippany	Burien	98166	
Daniel	Bronsdon	Seattle	98117	
Ricky	Lyman	Bremerton	98337	
Heather	Diepenbrock	Burien	98168	
Angel	Lopez	Kent	98032	Leave the green spaces alone! Paid airport parking is enough of a scam, don’t remove our trees and parks.
Andrew	Schmidt	Seattle	98119	
Francis	McMillon	Seattle	98115	
Corey	Cheshire	Seattle	98119	
Quoc Hung	Tran	Bellevue	98004	Leave the park alone
Cherlaine	Ordona	Tukwila	98188	There is a lack of green spaces and parks in surrounding cities outside of Seattle. Eliminating one of the parks (and one of the biggest) in the area is a detriment to those who use and live in this area. Not to mention that the proposed parking lot, is far from the airport which could create more traffic. Expand metro and transit options instead of clear cutting green spaces.
Jordan	Paseck	Burien	98166	

Melissa	Knudsen	Burien	98146	
David	Guilland	Shorline	98133	F* cars
Julian	Marquand	Seattle	98108	This is absurd, we have a light rail going straight to the airport - we don't need more parking lots, we need more trees!
Emma	Darmody	Seattle	98166	
Jared	Gothard	Seattle	98168	
Jessica	Collier	Burien	98268	
Brian	Becker	Seattle	98107	
Pierre	Berlan	Seattle	98122	
Adam	McJunkin	Tacoma	98416	
Max	Gray	Seattle	98125	
Ann	Magyar	Burien	98146	We made it clear last year that we want to keep the park. Do your job and find a plan that works.
Ryan	Knight	SEATTLE	98116	
Nicole	Ventoza-Jongjitirat	SeaTac	98168	Please leave North SeaTac Park and surrounding wooded area & bike/ walking trails alone! We've enjoyed this area since we moved to SeaTac, just down the street from the park 14 years ago. Our boys have grown up using these trails, walking & learning how to ride their bikes here since they were 3 years old. It's just a wonderful area & habitat for many of the wildlife in the area. They don't have many wooded areas left do to people taking over and developing THEIR land! There is absolutely no need for more parking space for the airport. There is airport parking on 24th that sits more than half empty every day of every week. I know, as I drive by it daily. There is also a fenced off area directly across from the parking on 24th they could utilize for parking if needed as people already had to leave their houses & land for the airport here. Please, please leave it alone!
Olena	Perry	Des moines	98148	
Aaron	Goldberg	Seattle	98122	
Valerie	Bank	Seattle	98118	Save the park! We do not need more parking lots
Johanna	Welch	Burien	98166	
Kim chi	Cheuck	Burien	98168	
Brianna	Y	Seattle	98102	Please preserve the forest!!! The trees, animals, and people who enjoy this space deserve to have access to a natural area!
Kavik	Frol	Seattle	98144	
Alexander	Mitchell	Seattle	98108	
Talex	Diede	Seattle	98144	

Steve	Mc Vay	Burien	98168	This park is a vital part of the well-being of the neighborhood
Pamela	Snyder	Tukwila	98188	This is an amazing green space that needs to stay in this day or urbanization.
Melanie	Wagner	Seattle	98146	
Clare	Terpstra	Seattle	98144	
Matt	Williams	Seattle	98106	
Blake	Mills	Seattle	98103	The city of SeaTac does not need more paid parking options to serve people who do not live there. The city should keep the park to benefit the actual residents of SeaTac. If the Port of Seattle wants to increase parking opportunities, they can invest in the multiple properties they already own and develop them. I'd rather see greater investment in public transportation than private opportunities that are not affordable for most of Seattle's residents.
Miles	McLall	Seattle	98119	We need better public transportation, not more parking lots.
Perry	Kent	Burien	98166	
Amy	Isaksen	Seattle	98107	
Mariana	Huben	Seattle	98136	
Crys	P	Burien	98146	Please honor the previous port agreement and preserve green space for the residents. This is a highly popular recreation area serving many cities.
paige	irwin	bothell	98012	
Ryan	Coplen	Burien	98166	Once developed, these parks will be gone forever. Every possible alternative solution must be employed before going after our shared green spaces.
Andrew	Chase	Seattle	98109	
Shar	Mc	Seattle	98116	Please leave the environment alone. The city has grown beyond capacity. There is no amount of money or development that will improve the quality of life for the residents or wild life in this area.
Christopher	Ward	Seattle	98126	
Tera	Johnson	Normandy Park	98166	
Brandon	Shults	Burien	98168	You should be ashamed of yourselves taking over beloved community green space and wetlands for parking lots
Joshua	Warborg	Seattle	98116	Stop! Why do you keep trying to kill this forest? You should ashamed of yourselves. The public has already spoken. Move on!!!
Kabri	Lehrman-Schmid	Seattle	98106	
Sarah	Varick	Federal Way	98023	
Jake	Fordyce	Bellevue	98005	
Jenny	M	Seattle	98117	Seattle can't be called the Emerald City if our green spaces are removed to put in parking lots. Leave North SeaTac Park alone and invest the money in more public transportation options so people aren't forced to travel by car and need to pay for parking.

justin	vice	seattle	98125	
Tristan	Seifert	Seattle	98102	
Chris	Murphy	Seattle	98107	
Jamie	Anderson	Renton	98056	
Andrew	Corman	Renton	98056	
Benjamin	Basaran	Seattle	98118	
Natalie	Johnson	Seattle	98102	
Scott	Flodin	Seattle	98122	Are you freaking kidding? Paving over green space that the city of Seattle and surrounding communities have precious little of anyways? No, expand public transit options or build a parking garage on top of an existing surface lot instead of ripping out trees those in the community value to put in parking. NOT a good look!!!
Nikita	Filippov	Seattle	98103	
Lisa	Eddington	Des Moines	98198	Please keep this lovely space as it is. Another parking lot is not needed. This park is so beneficial to the community.
Michael	Kao	Seattle	98117	Raise parking prices. Dont cut down more trees
Don	Johnson	Seattle	98144	
Anthony	Benavides	Tacoma	98467	
Chloe	Golden	Portland	97202	
David	Schultz	Bellevue	98004	
Dana	Reinhart	Renton	98056	
Andrew	Blancero	Seattle	98102	
Morgan	Gilchrist	Tukwila	98188	Access to green space, particularly space with trees, not just flat vegetation, has been shown to have a direct tie to mental health and overall well-being. The cities to the south of seattle lack green spaces in the same proportion as more privileged neighborhoods. Taking away this space - where people can walk, run, play organized sports, and breathe cleaner air, is an environmental and social justice issue. Paving this community space to create a private parking lot, miles from the airport, does not serve the community. The Port of Seattle produces their own Equity Index: “Using 21 indicators within four categories, the Equity Index illustrates the degree to which different communities experience pollution burdens and social inequities”. They rate SeaTac, Burien, Tukwila and surrounding areas as “very low” on this scale. They are clearly aware of the disparities between these areas and other parts of King County, and yet continue to propose changes that will only further increase these disparities.
Hasib	Yousufzai	Seattle	98144	

Nicholas	Caldwell	Seattle	98103	Please leave this ecologically important land alone. Parking lots can be built vertically...
Coehl	Gleckner	Redmond	98052	Keep our little bit of green left in seattle
Michael	Dean	Seattle	98119	Please don’t make more space for cars. It’s not needed.
Chelsea	Gould	SeaTac	98168	
Jennifer	Sheppard	Seattle	98108	
Kurt	Maurer	SeaTac	98188	
Julia	Anderson	Seattle	98107	
Katie	Betts	Seattle	98126	
Phoebe	Rogers	Seattle	98107	
Jason	Lukose	Seattle	98115	
Megan	Gryboski	Seattle	98122	
Samantha	Durham	Bellevue	98007	
Jarrod	Swarts	Seattle	98106	
Aaron	Bu	Seattle	98122	
Athena	Bautista	Seattle	98136	
Marlowe	Emmons	Seattle	98103	
John	Rito	Seattle	98136	
Erich	Lang	Seattle	98122	
Karena	Iliakis	Seattle	98105	
Chelsea	Sweeney	Seattle	98103	Parks are crucial to the health and well-being of the community and the environment. The land and the trees should be preserved and not replaced with a parking lot for the airport. The light rail is expanding and provides more opportunity for people to use public transit to get to the airport.
Brian	Grady	Issaquah	98027	
Bridgette	Eichelberger	Seattle	98109	
Patricia (Susan)	Whitaker	Burien	98166	If more space is truly needed then “They” need to make more use of existing lots such as building up instead of taking up more land! My husband are pretty new to the ares and I have only visited the park a couple of times so far but will again. We do feel it is important to the neighborhoods and can see that many families and individuals use the park a lot. Green space like this is so important to all of us. I also feel that it makes a lot more sense to raise the existing parking areas by several layers to make room for more parking rather than destroy a park important to the local communities.
Leigh	Sheridan	Seattle	98103	
Vamshi	Nandyal	Seattle	98136	
Rachael	Gomez	Seattle	98117	

JESSICA	MILLER	SEATTLE	98118	This is a non-renewable resource, not just to the human population of Seattle but also for its non-human residents that we share space with. Adding more parking has never solved the inherent problem; there needs to be more funding for mass transit instead.
Pearl	Barry	Burien	98146	
Victoria	Dennis	Snohomish	98290	
Jacob	Williams	Seattle	98109	You ruined the waterfront redevelopment with your demands for a huge surface highway. You prevented Stadium District developments. Please don't destroy a nice park too. The port has done enough damage to the community already.
Bennett	Tiglao	Seattle	98168	
Ashley Chenevert	Chenevert	Bothell	98021	We don't need more tarmac deserts. We should be focusing on making a move away from car-centric urban areas, making them more pedestrian friendly, and improving public transit (and thus reducing the number of vehicles on the roads contributing to pollution). Or commit to investing in EV infrastructure if we're pushing to get rid of combustion engine vehicles. Many climate change experts believe that we only have until 2040 to make changes, and likely even less time than that.
Malinda	Krisel	Normandy Park	98166	
Ann	Guinee	Seattle	98102	
Rick	Hamell	Portland OR	97220	I visit this park quite often when I'm in town on business. It is an amazing place to be, and obviously means a lot to the community. Loosing this park will mean loosing my money and business when I am in town as I'll simply stop in Olympia, Tacoma or Kent instead. Removing parks from communities is the second best way to kill a community.
Hunter	Merrill	Seattle	98103	
Maguire	Manthey	Tacoma	98406	I have a lot of personal and family history with the park, as my Dad’s Grandparents grew up on that land, and it is super cool to be able to race bikes on those same grounds. Aside from that, it is a protected piece of land, and to use it for an industrial purpose is a clear sign that the Port of Seattle as well as King County are not committed to sustainability. That land has value far beyond racing, history, etc. and how it is treated sends a clear message to the constituents of King County.
Caitlin	Buckley	Seattle	98121	
Nelson	Lowhim	Seattle	98122	Please don't pave over our parks. We have too few as it is. And certainly not for a parking lot
Linda	Warfield	SeaTac	98188	
Kanna	Bowman	Shoreline	98155	
Ame	Bowman	Shoreline	98155	
Matthew	Small	Tukwila	98168	
Sean	Day	Seattle	98119	
Jack	Cantlon	Seattle	98119	

Max	Eichelberger	Seattle	98101	
Mark	Sheaber	Tukwila	98188	
Leah	Pham	Burien	98166	
Shannon	Slevin	Tukwila	98168	We love SeaTac park and live close by! Please do not turn this park into an airport parking lot. This creates a potential risk factor for the neighborhood and less opportunities for community to build
DANIEL	BARRY	Burien	98146	
J	T	Seattle	98133	Green spaces > businesses. If they want land for a parking lot let's not destroy a beautiful natural area, but instead they can purchase any of the already developed existing land around the airport and turn it into a parking lot.
Chanel	Young	Seattle	98122	
Geoffrey	Howie	Seattle	98122	
Cameron	McCrea	Tacoma	90422	
Nishant	Prasad	Kent	98031	
Devon	Cook	Burien	98148	
Jessica	Varsames	Portland	97206	
Casey	Colvin	Burien	98168	
Save	Ghare	Seattle	98021	
Valerie	Mehring	Seattle	98125	
Colleen	Molloy	KIRKLAND	98034-7431	
Elizabeth	Furlan	Bellevue	98004	
Seth	Wagner	Bothell	98021	
Vince	Partridge	Seatac	98188	
Jovan	Zhang	Seattle	98122	This is one of two very important disc golf parks in the Seattle area which many people volunteer and dedicate a significant portion of their personal free time to upkeep. Removing this is a massive middle finger to those people as well as players and park goers.
jorge	castro	seattle	98101	
Constance	Chen	Kent	98032	
Hai	Nguyen	Shoreline	98133	North Seatac is a treasure for this city and one of the last true greenspaces
Max	Davidoff	Seattle	98105	Don't remove the park. It's perfect and I spend time nearby here disc golfing.
Mathew	Irvine	Burien	98166	
Justin	Cranson	Seattle	98109	
Patrick	McCabe	Tacoma	98406	

Anthony	Steinbacher	Bremerton	98311	
Andrew	Steers	Seattle	98117	
michael brazel	brazel	FEDERAL WAY	98003	This Spark has a unique undeveloped feel with Mt bike trails and lots of shaded canopy. Hundreds of Mt Bikers from all Tacoma to Everett enjoy these trails EVERY week and local residents can be found walking dogs and enjoying the forested environment in the middle of the city. Spaces like this cannot be replaced once taken away. PLEASE save our green spaces!!!!
Anna	Stevens	Seattle	98115	
Olivia	Fick	Bellevue	98005	This land has a great deal of sentimental value to the people of Seattle.
Paige	Hineline	Seattle	98103	A parking lot is the least valuable use of land and cars destroy communities and the planet. Do better you cucks.
Robert	Doherty	Seattle	98109	
Jason	Gorman	Tukwila	98168	Please leave our parks alone. We wish to continue using them for recreation near our homes and for future generations to do so as well.
alexander	brassel	seattle	98103	
Katya	Downey	Seattle	98117	How did that song about "paving paradise" go again?
Kevin	Johnson	Burien	98116	A bland parking lot would suck. Build an underground garage so we can keep the park AND parking is available. During construction, relocate surrounding restaurants into kiosks at the airport so they can come back stronger
Jeff	Rosenblum	Seattle	98122	
Cheronne	Oreiro	Seattle	98108	
Kelly	Nelson	Seattle	98136	
Jonathon	Bowyer	Seattle	98102	More trees, more mass transit, less cars. Keep our cities walkable and beautiful.
Mac	Wright	Seattle	98126	
Jeannette	Yu	Bellevue	98005	Plant trees so the next generation can enjoy the shade.
Jordan	Mollot	Seattle	98118	
Tess	Milom	Shoreline	98133	Don’t pave paradise to put up a parking lot!
Michael	Meinecke	Tacoma	99163	
Alex	Dikelsky	Decorah	52101	
Mike	Adams	Burien	98168	no
David	Skidmore	Seattle	98115	
Jonathan	Hamilton	Renton	98059	
Cody	Shaner	Seattle	98125	
Anderson	Wu	Seattle	98122	
Jeff	Rivait	Seattle	98178	

Joseph	Tilghman	Seattle	98126	I work 5 minutes from this park and utilize it several times a week. I love the park, my wife loves the park, my dog adores the park, and I paving it to throw up some parking lots is an idiotic idea that should get whomever suggested it fired. Quit screwing with public green spaces. Parking here would be inconvenient for everything. It isn't close enough to the airport, it isn't close enough to mass transit. The only thing it has going for it is that you already own it and that's a pretty stupid way to make decisions like this.
Caitlin	Bowman	Seattle	98125	
Norah	Dreher	Seattle	98122	
Thomas	Breit	Seattle	98133	
Lars	Dugger	Tacoma	98407	Parking lots? Really? Trying to tear down a community forest so you can put up a giant parking lot that just sits there vacant and unused half the time? What a selfish and unwise use of land. How about investing in alternative modes of transportation to the Port instead?
Diane	Deaver	Burien	98166	
christine bertie	bertie	SEATAC	98168	
Patrick	Burns	Bothell	98021	
Carlee	Ummel	Kenmore	98028	
Yuanyuan	Lei	Seattle	98119	
Jillian	Igarashi	Seattle	98118	
Katie	Saunders	Enumclaw	98022	We need more public transit, not parking spaces. Save our park and convert some other space for public transit.
Lucas	Shuck	Seattle	98126	
Dalton	Huey	SEATTLE	98106	
Oliver	Boal	Seattle	98102	
Nathan	Vig	Seattle	98101	
gabi	esparza	renton	98059	
Rachael	Contorer	Burien	98146	Paving over our precious urban green space, especially under Sea-Tac’s flight path, is short-sighted and irresponsible. Ban Port development of North Sea-Tac Park, please!
Rebecca	Werner	Seattle	98102	
Joshua	White	Poulsbo	98370	
Aneesha	Singh	Seattle	98105	
Wing Cheung	Ma	Seattle	98119	
Peter	Smith	Burien	98168	
Kimberly	Tate-Malone	Shoreline	98155	
Rachel	Partridge	Seattle	98103	

Katie	Petersen	Burien	98146	We need this park. There is a serious lack of safe play spaces for kids and this is one of our favorites
Samuel	Zimmerman	Renton	98056	
Jedidiah	doyle	Seattle	98168	It is critical in the point of history that organizations are met with absolute resistance when disregarding the factors earth is facing. What little canopy is left, the Port of Seattle clearly is disregarded in their redundant efforts to dismiss the interests of the community, animals and natural habitats. There are options that being dismissed, the efforts are falling very short. Many people in the community are not aware of this attempt to destroy this piece of land. Many people and animals find refuge in this piece of land. Many people that are shadowed under the flight path of excessively loud planes that are being ignored. The forest that has fought back does make a difference to well being of animals and human life in this area. The parking lot goes against the all intuitive choices to life. Please stop, because we will not simply ignore this. You half a half empty parking lot 1/4 mile closer to the airport which the land has already been clear cut. Be creative and conscious.
Ariana	Hayes	Seattl	98118	
Catherine	Garrett	Seattle	98103	
Jayne	Bosch	Burien	98166	
Ankit	Nair	Shoreline	98155	
Stefanie	Krug	Seattle	98144	Please protect our park and greenspace!
Christopher	Francis	Seattle	98103	
Justin	Hendrick	Renton	98056	Don't pave paradise to put up a parking lot
Yeliz	Karadayi	Seattle	98121	
Kendall	Moffitt	Everett	98201	
Madeline Dayley	Dayley	Seattle	98107	
Daron	Purcell	Burien	98166	
Paul	Davis	Seattle	98102	
Tim	Coye	Kirkland	98033	
Debra	Aguilar	Burien	98168	
Mario	House	Des Moines	98198	
Erin	Bailie	Seattle	98103	
Harry	Chung	Port orchard	98366	
Erin	Peachman	Seattle	98103	
Crosby	Schultz	Seattle	98109	
Sean	Muir	Seattle	98103	
Sean	McDonald	Seattle	98119	

Joshua	Herring	Seattle	98144	
Simon	Senter	Seattle	98115	
Kristen	O'Conner	Burien	98166	We need our trees.
Alykhan	Sunderji	Seattle	98112	
John	Marino	Seattle	98115	
Caley	Jansen	Seattle	98168	I enjoy this park every single day with my family, my dogs, our bikes, etc. it would be devastating to this neighborhood and seattle residents to lose so much valuable park land. Please do not commercialize! Seattle is running out of good reasons to stay here.
Reed	Correa	Seattle	98102	
Zach	Hale	Seattle	98107	
Emma	Follender	Seattle	98103	
Keenan	Reynolds	Seattle	98146	
Paul	Sowers	SEATTLE	98109	
Grant	Taylor	Seattle	98144	
Ryan	Youngman	Seattle	98104	
Grisel	Viveros	Seattle	98168	Porfavor no hagan parking en este hermoso espacio natural por q mis hijos les gusta ir a caminar y respirar aire fresco
Megan	Blandford	Seattle	98103	
Sarah	Hager	Seattle	98108	This park has been pivotal in my exposure to different kinds of bike riding and community
William	Millhollin	Burien	98166	
Sarah	Derry	Burien	98168	This park is near my home and j use it regularly. Please do not turn my neighborhood park into yet another parking lot!
Benjamin	Dorrough	Burien	98168	
Collin	Kindred	Spokane Valley	99206	
Jessika	Verduzco	Seattle	98103	
Julia	Hayano	Seattle	98105	
Sawyer	Pouliot	Burien	98168	We breathe jet fuel day in and day out. Our children can’t play outside some days because it’s so bad. Do NOT take away our park space.
Ian	Corey-Boulet	Seattle	98102	
Britta	Voss	Olympia	98506	
Austin	Werner	Seattle	98122	
Maya	Cruz	Tacoma	98407	
Nick	Honomichl	SEATTLE	98108	Stop destroying our parks!
Andrew	Hartman	Seattle	98109	

Vigneshwar	S	Bellevue	98005	
Zach	Nostdal	Seattle	98178	
Pamela	Grad	Kent	98042	
Amanda	Mayberry	Burien	98148	
CODY	MANDT	kirkland	98034	
Drew	Vance	Seattle	98107	
David	Christensen	Seattle	98107	
Emily	Louden	Bellevue	98007	
Daniel	Mayberry	Burien	98148	
Katarina	Kubiniec	Seattle	98122	
Ben	McGee	Seattle	98118	
Robert	Zahn	Bellevue	98007	
Danica	Cassidy	Seattle	98102	
Nicholas	Wax	Shoreline	98115	Access to single track and mountain biking trails are few and far between. This is an excellent community resource that should be maintained at all costs.
Angela	Tran	Everett	98208	
Michael	Schueler	Seattle	98106	
Evan	Anderson	Bothell	98011	
Amy	Jewett Peters	Seattle	98118	Don't pave paradise to put up a parking lot... Seriously though, I don't want the park to be paved. Keep our green spaces green.
Henry	Trease	Issaquah	98029	
Miranda	Arney	Burien	98168	
Jackie	Benegas	Seattle	98117	
Morgan	Johnstone	Seattle	98106	
Austin	Yanoti	Las Vegas	89119	
Connor	Carlson	Seattle	98104	
Owen	Anderson	Seattle	98125	
Issra	Syed	Tukwila	98168	
Tracey	Schmidt	Des Moines	98148	
Donald	Turnbaugh	Tacoma	98406	
Erika	Spongberg	Des Moines	98198	
Jonathan	Michaelchuck	seattle	98118	
Beck	Gilmore	Tukwila	98168	Our cross country team holds meets here, to pave it over would be a waste of such a great outdoor space

Vincent	Rivera	Sammamish	98075	
Daniel	Castro	Seattle	98106	Preserve nature, you clowns
Lizzy	Thorne	Olympia	98501	
riley	britt	Seattle	98102	
Hans	Loesch	University Place	98467	
Jonathan	Wicks	Hermosa Beach	90254	theres already enough parking at seatac
Loraine	Kanervisto	Seattle	98144	
Rick	Menesini	Seattle	98146	
Zane	Keehbler	Seattle	98102	
Max	Kerwien	Seattle	98105	
Harry	Stevenson	Seattle	98101	
Thomas	Maier	Des moines	98148	
Vern	Cole	Kent	98042	
Alexis	Moy	Seattle	98126	
Nicole	McRaney	Covington	98042	
Luke	Taylor	Bellevue	98007	
Piyush	Revuri	Seattle	98122	
Mark	Schmidt	Des Moines	98148	Leave it alone! You've already destroyed the neighborhood enough, let this gem of a park be.
Carolyn	Hanson	Burien	98168	
Dylan	Westfall	Seattle	98108	
Riana	Nolet	Burien	98166	
Briar	Moench	Seattle	98122	
Mary	Fisher	Seattle	98107	
Colleen	Webb	Seattle	98122	
Bret	Wolter	Seattle	98105	
Reuben	Dunnington	Seattle	98133	Green spaces are wayyyyy more important than parking lots. Consider funding other transit, climate-friendly options instead of encouraging people to drive!
Mitchell	Hallman	GIG HARBOR	98332	
Hannah	Chen	Seattle	98125	
Andrew	Schwartzmeyer	Seattle	98104	This park is an absolute treasure enjoyed by people from miles around. I bike down from Seattle to see the forest and ride the trails. It’s a tragedy the port would even consider deforestation (again).
Martin Yang	Liu	Bellevue	98006	

Abhinav	Taliyan	Seattle	98103	
Ross	Parker	Dupont	98327	
Sally	Ho	Kent	98032	
James	Smith	Decatur	30032	
Sarah	Brende	Seattle	98118	
Tom	Esser	Burien	98146	
Tiffany	Skidmore	Port Orchard	98366	
Alysia	Blanding	Federal way	98023	
Patrick Burke	Burke	Seattle	98104	I thought our Port elected officials were supposed to be "progressive". Literally taking away a local paradise for some, to put up a parking lot. They should be ashamed.
Amber	Frederick	Burien	98168	
Krystina	Colton	seattle	98125	
Jacob	Mayo	Redmond	98052	
Chanda	Zenor	Auburn	98002	
TIM	GROEN	Seattle	98103	
Mia	Concordia	Burien	98166	This is a beloved local park. Please don't deprive our children and families of this rare outdoor space.
Michael	Curtis	SEATTLE	98168	
Justin	Haugen	Seattle	98115	
Unpublished name		Seattle	98122	Why, in 2022, are we still fighting to save one of our few remaining green spaces?
Daphne	SPAKOWSKY	Auburn	98001	
Erik	Phillips	Seattle	98116	
Dean	Kelly	Kent	98032	
Jake	Lally	Seattle	98109	Put the cars somewhere else. Parks are a valuable resource.
Kay	Lee	Des Moines	98003	Please stop the expansion. Honor START solution! Stop the polution and air noise
Anna	Whitney	Burien	98146	
Mackenzie	Johnson	Seattle	98125	
Sophie	McGarity	SeaTac	98168	
Michael	Powell	Seattle	98106	
Jessamyn	Cufley	Seattle	98116	
Tracy	Fairfield	Redmond	98052	
Michael	Voorhees	Seattle	98106	
Kyla	Cotter	Burien	98168	

Andrew	Melvin	Seattle	98115	This park is important for the community which already deals with the negative health and environmental impacts of frequent flyovers. We need more greenspace in our communities not more parking lots. With the expansion of light rail there is less need for parking at Seatac, not more. If the Port would like to address parking issues, they should spend money educating people about how easy and efficient it is to take transit to the airport, not by destroying local parks.
Catherine	Vu	Newcastle	98056	
Jonathan	White	Seattle	98122	
Holly	Roa	Burien	98146	
Jackson	Li	Seattle	98199	
Allison	Dietz	Seatac	98198	
Jimmy	Schulz	Burien	98166	
Marci	Martinez	Seattle	98107	I grew up on these trails. There is no other park like it. Please don't cover it in pavement.
Rant	Casey	Maple Valley	98038	
Riley	Murphy	Redmond	98053	
Tuan	Nguyen	Renton	98059	
Denis	Treskunov	Seattle	98119	
Anya	Machleid	Seatac	98168	This park means so much to do many people & we don’t need anymore huge contribution to climate change.
Chris	Holstrom	Seattle	98115	Don't pave paradise to put up a parking lot.
Whitney	Gretch	SeaTac	98168	
Britney	Bui	Seattle	98168	
Serina	Lopez	Seattle	98136	
Ian	Johnson	Seattle	98116	
Jacob	Chapman	Poulsbo	98370	
Allison	Schiller	Seattle	98133	
Taylor	Bancroft	Boring (OR)	97009	
Bryan	Rice	Bothell	98011	
Aaron	Hedquist	Seattle	98122	
Glen	Claytor	Seattle	98115	Please keep this gem of a park.
Jeff	Oliver	Seattle	98146	
Adam	Hollis	Seattle	98321	
Frances	Johnson	Seattle	98008	Live up to your stated promises to promote public good, diversity and racial equity by protecting green spaces in the communities you impact!

H	Berry	Seattle	98125	
Brianna	Orellana	Burien	98125	This is my childhood park, not only has it been a significant part of the community who's grown with it but it also provides us with the nature we tend to lack around this area surrounded by the airport.
Nicholas	Carter	Seattle	98087	
Patricia	Goodwin	Des Moines	98103	Please preserve this important green space for our communities! There are other viable options for airport parking—do not target this beloved and highly-used park!
Bill	Toukan	SEATTLE	98033	
Soliman	Alnaizy	Seattle	98136	We don't need more parking lots
Maddie	Foley	Seattle	98101	
Amanda	Hodges	Seattle	98019	This is unacceptable. The green spaces are needed to help mitigate some of the pollution the airport causes to the neighboring communities that have lower lifespans because of the pollution. The impact on our environment is enough and you guys keep trying to destroy more. If you need parking, try somewhere that isn't destroying a community park and Wetland.
Jamie	Nishimura	Seattle	98057	NO PARKING LOT, MORE GREEN SPACES
Paul	Blaney	Seattle	98118	
Amanda	McCullough	Burien	98104	
Tasha	Weiss	Seattle	98003	
Jered	Martin	Seattle	98312	I like this park
Stacy	Gonzale	Whitecenter	98188	
Kelsey	Jennings	Buckley	98144	I was born and raised in Seatac, want to preserve the park land that is left
Chase	Hawthorne	bellevue	98108	
Jonathan	Ostojic	Seattle	98144	
Shambhavi	Taylor	Seattle	98033	
Laurel	Taylor	Lynnwood	98107	
Zoe	Bloom	Seattle	98109	
Satyen	Subramaniam	Seattle	98032	
Peter	Wright	Seattle	98168	Don't sell the godamn park.
Ben	Tisdale	Duvall	98144	
Ashley	Tanaka	Seattle	98005	
Michael	Supanick	Seattle	98003	
Kyle	Novak	Federal Way	98144	You don't need more parking spots.
Jessica	Storey	Bremerton	98133	

Christa	Donoso	SeaTac	98028	
Ian	McKinley	Seattle	98144	
Carlos	De Anda	Seattle	98021	
Eric	Syinson	Seattle	98119	This is both a bad location for a parking lot (across from a school for crying out loud) and a great park.
Christian	Laney	Kirkland	98166	
Quentin	Thornton	Seattle	98198	
Forest	Lisinski	Seattle	98146	
Justin	Koch	Kent	98122	Parks are the future we need for humanity and not another concrete place. Find some of the rundown buildings that can be turned into parking. Several off 99
Diana	Mena	Burien	98115	Put people first before profits.
Tyler	Sakraida	Bellevue	98118	Save the Parks! Save the forests!
Alan	Lin	Seattle	98198	
Aaron	Russo	Kenmore	98122	
Tess	Warner	Seattle	98103	
Jeff	Dicker	Bothell	98168	
Tracy	McAlpin	Seattle	98056	
Rachel	Coburn	Normandy Park	98104	
Christopher	Urbanski	Des Moines	98087	
Madeline	MacDonald	Seattle	98105	
Alexander	Montelione	Seattle	98092	
Michael	Nguyen	Seattle	98168	
Mark	Chandler	Des Moines	98006	Build your parking on already developed land. Leave parks out of it.
Adam	Ratzman	Seattle	98146	
Thi	Phomprida	Seattle	98148	
DeAnne	Falls	Renton	98148	I grew up in this area and I remember when the original neighborhood was demolished and the park was built. We lost neighbors but got a place to gather in return. The residents of this area deserve to have a place to walk and play. I understand the importance of growth and change, but so many things have been tailored to fit the needs of the Port of Seattle/SeaTac airport without any regard to the people who live there. Taking away the one place for recreation would confirm how little the homeowners and families mean in comparison to the revenue that could be generated. The needs of the community and future generations should ALWAYS come before the wants of the Port of Seattle.

Josh	Wymyslo	Seattle	98115	
Evin	Fairchild	Lynnwood	98166	
Claire	Johnson	Seattle	98034	
Marcus	Burklow	Auburn	98168	
Sandeep	Dey	Bellevue	98059	
Katie	Colpitts	Burien	98101	
Cillian	Murphy	Seattle	98148	
Cam	White	Burien	98444	Protect this area that has taken centuries to develop.
Maria	Lychagina	Kirkland	98103	
Aaron	Guzman	SeaTac	98155	
Brian	Hughes	Renton	98118	
Lauren	Elisabeth	Des Moines	98188	Please do not allow polluting corporate interests take away from a vital community meeting place. North SeaTac Park is a gem and should be protected.
Cassady	Surfleet	Seattle	98003	It is disgusting that in 2022 we have to fight to save trees and green space.
Frank	Massaro	Shoreline	98168	
Sean	Siem	Seattle	98108	
Sarah	Rogers	Federal Way	98106	
Evan	levene	Burien	98105	
Marenka	Dobes	Seattle	98040	
Kathleen	Richards	Seattle	98188	
aiden	Smith	Seattle	98109	
Lulu	MacKinnon	Mercer Island	98103	
Amanda	Andrade	Tukwila	98107	
Kat	Player	Seattle	98012	
Taylor	Rulien	Seattle	98004	
Jaden	Condon	Seattle	29403	
Cory	Kaldestad	Mill creek	98168	
Dwina	Solihin	Bellevue	98146	
Harry	Schmidt	charlesotn	98188	
Mary	Hamel	Burien	98290	
Erik	Sullivan	Seattle	78653	
Phillip	McKnight	Snohomish	98166	
MICHAEL	BOND	Burien	98103	Shame on Port of Seattle. We need more parks and green spaces, not parking lots.

Julie	Kenworthy	Seattle	95609	
Alyssa	Mahoney	Burien	98146	
Chris	H	Vancouver	98662	
Kelly	Cline	Redmond	98052	
Stephanie	Hook	Tacoma	98405	
Unpublished name		Tacoma	98119	Figure out your car problem. Get creative. Run some buses. You don’t get to ruin a public park forever
Unpublished name		Kirkland	98105	Incredible park. Incredible buffer. Incredible loss if this park is appropriated for other uses.
Unpublished name		Burien	98118	Our mom group like many others walk this park multiple times a week.
Unpublished name		Seattle	98102	Parks > parking lot
Unpublished name		Seattle	98155	Parks are more important than parking.
Unpublished name		Kirkland	98168	Preserve our environment please. Parking lots will do the public no good.
Unpublished name		Seattle	98102	Preserve our park and community!
Unpublished name		Burien	98052	Promises made but never kept... seems to be the motto of the Port. The 3rd runway is a good example. This land belongs as permanent park land. Hands off!
Unpublished name		Tacoma	98122	Save parks
Unpublished name		tacoma	98109	save the trees <3
Unpublished name		Seattle	98107	Stop trying to destroy our parks for parking lots!
Unpublished name		Tacoma	52101	Thank you!
Unpublished name		BOTHELL	98155	This is a "pave paradise to put up a parking lot" situation. Do better.
Unpublished name		Shoreline	98104	This is a lazy answer. You can do better than this. Build up not out. Build more park and rides along the light rail. Stay away from our open spaces.
Unpublished name		Seattle	98103	This is a special asset to this area creating community and clean air. I first started mountain bike racing here and love the camaraderie it brings.
Unpublished name		Burien	98168	Bear in mind that green spaces are crucial for humans, animals, insects and so forth. There's plenty of studies to support this idea. Protect our green spaces in perpetuity.

Unpublished name		Seatac	98168	How about you use the massive empty field that is owned by Boeing for this? How about the huge empty lots foreign investors are sitting on to gain equity? Why destroy rare and beautiful natural areas that the public enjoys when there is plenty of land to use outside of this natural wonder. When I walk I see owls I hear frogs and see the beautiful wonder if nature. Will you see owls nest destroyed? Will you see the frogs die? The public has paid enough in it's labor and taxes just to see their natural beauty molested in the name of private interest. This does no good for the people and benefits only private interest. The people have said multiple times. How about the city goes back to the massive private interest who benefit greatly from our tax dollars and ask them for land, they can afford to buy one less yacht the people cannot afford nor will the stand with the rape of our natural wonders.
Unpublished name		Boulder	80302	It would be absolutely insane to bulldoze one of the most beautiful city parks in the US to build a parking lot. I've spent a lot of time in Seattle and SeaTac park is an irreplaceable part of the city.
Unpublished name		Kent	98031	North Seatac Park is a vital green space for immediate and surrounding communities. It hosts sports and recreation, walking trails, has a BMX track, RC track, a botanical garden, and deserves to be preserved as-is and even better, supported, safer and improved. The Port instead needs to focus on better, safer, more reliable transit to the airport and develop better parking facilities to be able to minimize traffic and parking directly ext to the airport. For example, Tukwila International LRT station, has a very small surface lot for the volumes it could handle. Increase security and build a multi level parking structure on top of the current lot footprint. Have upper levels be limited term airport parking with a green roof. Introduce airport shuttles from the Burien Transit station. With a parking structure already present, partner to bring airport parking to the upper levels there. PLEASE do NOT take over green space. Get smarter about utilizing current and more sustainable options for personal vehicles. If we are ever to move forward in our state’s and metro area’s commitment to sustainability as cannot keep looking at land as usable when so much has already been taken over by blacktop. Save North Seatac Park!!
Unpublished name		Seattle	98126	Parking is a waste
Unpublished name		Maple Valley	98038	Please do not turn this park into a parking lot. We need more green spaces, not fewer.
Unpublished name		Seattle	98148	Please leave our limited greenspaces alone.
Unpublished name		Seattle	98144	Save the park!
Unpublished name		Seattle	98121	We don't need more parking lots and rather we need more public transport. Please stop destroying natural habitats
Javier	Hernandez	Seattle	98168	
Kimberly	Fee	Burien	98166	
Cameron	Bagley	Seattle	98144	
Jessica	Wilson	Seattle	98121	

Hunter	Mason	Bellevue	98007	
Ryan	Rimsnider	Burien	98166	
Mindy	Hart	Burien	98148	We need our park!!
Daniel	McNair	Philadelphia	19121	
Ian	Boudreaux	Seattle	98119	
Micaela	Pearson	Burien	98148	
Pat	Farris	Tukwila	98168	Don't pave paradise and put in a parking lot.
Chris	Mornick	Burien	98146	
Chidozie	Nwobilor	Seattle	98118	I believe it's important to preserve the green and natural spaces we have left. Also encouraging more car use is not the way to go.
Alyssa	Sunseri	Renton	98058	
Brooke	Hudson	Seattle	98105	
Janolin	Higgins	Seattle	98102	
Evelyn	Qin	Seattle	98122	
Michele	Smith	Burien	98146	Developing this area that is so critical to the health of the community and the wildlife cannot be an option. People who enjoy the park and animals who have no choice but to live there since the airport expansion and Tub Lake Bog cannot be risked. We will not accept this.
Abram	Clark	Shoreline	98155	
Elliot	Swanson	Seattle	98125	
Diane	Zaida	Auburn	98092	Love the park. One of the treasures of SeaTac. We don't need another parking lot!
Vivek	S	Seattle	98001	
Benjamin	Sullivan	seattle	98103	
Emil	Anderson	Seattle	98177	Save packs. people and nature first.
Carlene	Reyes	Seattle	98103	
Gabriella	Malone	Bear	19701	
Diana	Betancourt	Kennewick	99338	
Jake	Smith	Seattle	98122	Please explore transportation options that do not result in the destruction of a green space central to the Seatac community.
Amy	Postel	Burien	98166	I work adjacent to this park and walk the paths during my lunch break. I see so many people from the community using it of all ages and races. My children and their peers have used this park for lots of activities. The community needs this space to encourage mental, physical, and social wellness. Think of how crucial this has been during the pandemic. In addition, I read there was a promise that this space would always be a park when people gave up their homes for the runway. Please do not take this away.
Tawni	Ryan	Seattle	98108	

Jill	Kendall	Seattle	98103	
Kristina	MUSGA	Seattle	98168	I have grown up around this park. It was built in my early childhood. And now, my children enjoy it. It is one of the last remaining large, local areas we have to enjoy with our family. We DO NOT want to see the land turned into anything else but what it is today, a place for the community to enjoy the outdoors and come together in.
Jay	Henriques	Seattle	98115	Greater Seattle area is growing in population and we need to preserve as many green spaces as possible for all to use.
Micheal	Kilpatric	Seattle	98168	
Ben	Adair	Seattle	98136	
Craig	Batson	DES MOINES	98198	NO MORE PARKING. MORE PARKS
Lily	Gordon	Seattle	98106	
Austin	Brinegar	Lynnwood	98087	
Caleb	Salmon	Beaverton	97005	
Mackenzie	Krell	Kent	98032	
Selene	Russo	Seattle	98106	We need to keep all the open green spaces we have! Especially trails like this that are so important to the community.
Cameron	Stewart	Farmington Hills	48335	Love this park
Anna	Simonak	Burien	98166	To Whom it May Concern: This park is a beautiful and essential place to take respite in nature for the areas surrounding it. For many families who rely on public transportation this is a accessible place to explore and relax in nature. This is such a special resource and it would be a huge blow to the community to lose some of the acreage of this park to infrastructure. I live near the park and am so grateful for it's outlet to nature that is so close to my home. I usually go at least once a week to walk my dog and enjoy the trees. I implore you to reconsider developing this precious community resource. It is such a special place to so many people.
Katrina	Ooms	Seattle	98106	
Beth	Mallalieu	Burien	98146	
Jim	Denison	Seattle	98118	
Aniya	Lynn	Seattle	98168	
Angelina	Gonzalez	Seattle	98146	
Sean	Moss	Seattle	98118	
John	Armstrong	Seattle	98103	
Jack	Liedtke	Seattle	98105	
Caitlin	Head	Seattle	98122	
Shane	Moran	SeaTac	98168	Leave our park alone
Alyssa	Moran	SeaTac	98168	

Sean	Moran	SeaTac	98168	
John	Lestina	Seattle	98115	If we care about the environment, the last thing we should be doing is building more space for cars.
Riley	Revell	Seattle	98199	
Ashe	Loughrige	Seattle	98122	
Taylor	Lamb	Snohomish	98296	
Danielle	Osborne	Burien	98166	
Shauna	Bakkensen	Burien	98168	Please consider other already existing paved options. It's unequitable to have people from other communities deemed more important than the residents of this area. Tree canopy is incredibly important in filtering airplane pollutants. Green space contributes to environmental health and mental health. Possible alternatives: leasing parking lot space from Westfield mall (parking lot N. of Macy's). There is a busline nearby, or a commuter van could be provided. Or lease parking from T-mobile park for their parking structure.
Steven	Pautler	Seattle	98115	
Amber	Pulido	Seattle	98122	Keeping green spaces is a win for the climate, a win for all people, a win for the ecosystems. Please please don’t ignore these in favor of parking
Kaye	Miller	Burien	98148	
Scott	Novotney	Seattle	98115	
Madeleine	Winward	Seattle	90166	
William	King	Redmond	98052	
Thomas	Riess	Seattle	98107	Please save and protect the North SeaTac Park. It is a invaluable resource for the community with multiple uses and used by people old and young, and from near and far. The area already has a scarcity of parks and recreation areas. Please don't degrade our community by removing North SeaTac Park
Elena	O’Neill	Seattle	98112	I love taking light rail to the airport. Yet even when hauling my 5-person family, all of our luggage, and a car seat to the airport these days, I take an Uber instead of driving. I’m not at all convinced that future demand for SeaTac parking means destroying such a vital community resource and one of our last remaining bogs (!).
Alex	Hughan	Seattle	98102	
Krista	Jefferson	Kent	98031	
Emily	Cole	Seattle	98103	
Mikhail	Kolesnik	Kirkland	98034	
Katherine	Brown	Issaquah	98027	
Vi	O'Conner	Burien	98166	I grew up near this park, I witnessed the baseball fields built and spent many summer days practicing my swing there. It was the first basketball court I ever dunked on and I as well as my family would be devastated to see it become anything else. Thank you for reading.

Melanie	Price	Shoreline	98155	Save the wetlands!
Andrew	Freeling	Seattle	98133	
Jessica	Alexander	Seattle	98103	We need more trees, not fewer. Protect human health by protecting the environment.
Brandon	Andre	Seattle	98177	Use of North SeaTac Park is vital for my health.
Sheila	Spiker	Burien	98148	The environment and the neighborhood would be much better served by a park - not another parking lot. Don’t demolish one of the last remaining green spaces in the area to park cars.
Michael	O'Neill	Edmonds	98026	
Zak	Hale	Shoreline	98155	
Jacob	OConnell	Renton	98058	
Todd	Storch	Maple Valley	98038	
Achille	Heraud	Seattle	98109	
Edward	Fenwick	Seattle	98102	
Kyle	Upton	Tukwila	98188	This park is a gem for the entire South Seattle area.
Mark	Watson	Renton	98178	
Ray	Beck	Seattle	98126	This park was created to compensate area residents for airport impacts. The trees in & near it protect residents from airport pollution.
Dana	Hamilton	Seattle	98115	
Shelley	Jin	Seattle	98115	Dude, the park is great. It's one of the few greenspaces remaining in Seatac and I've always enjoyed dropping by after flying in during a work trip. Paving it over is an awful idea.
Thomas	Garcia	Tacoma	98405	
Miles	Payton	Austin, TX	78722	I loved riding my bike in this park when I lived in Seattle. Why such an advanced, progressive city would trade a carbon sink for a parking lot baffles me. Incredibly backwards thinking.
Josiah	Dells	SeaTac	98168	
Gwendalyn	Charette	Seattle	98168	
Trevor Scott	Scott	Seattle	98168	Leave the trees alone!!!
Michael	Scholl	Seattle	98103	
Bruce	Davidson	Burien	98146	Commercial expansion cannot continue at the expense of green space sacrifice. The developers reject the word "limits"; government must force the developers to abide by them.
JACOB	LAUGESON	Seattle	98125	Build vertically on land you already have.
Barbara	Conner	Kent	98031	Please preserve this open space for residents
Brennen	Cohea	Seattle	98121	
Amanda	Templar	Burien	98166	

William	Shawley	Burien	98168	
Allison	Ostrer	SEATTLE	98146	Acquire all of North SeaTac Park and protect it permanently.
Erik	Peterson	Burien	98166	
Unpublished name		Redmond	98052	Parks matter! Green spaces matter! SeaTac doesn't need more airport parking – with rapid transit busses and link transportation expanding, there's plenty of way to get to the airport without expanding individual parking spaces. Are we really still fighting to keep green spaces alive in 2022? It should be a given at this point.
Unpublished name		Seattle	98107	Please save the park. It's an amazing resource for the community. I challenge the port officials to spend 24hrs under the flight path before making any decisions.
Unpublished name		Seattle	98199	There is enough parking for the airport. You need to plant more trees to offset the carbon dumping out of the planes, not remove the existing trees that are keeping the air quality reasonable.
Unpublished name		Bellevue	98005	We need more than ever to preserve our green spaces. We are the evergreen state, we need to live it.
Hilary	Lawlor	Seattle	98102	
Stuart	Leitch	Tacoma	98422	Park space is far more precious than yet another lifeless grey parking spot. In the climate crisis we need to preserve green areas. Paving over would just be going backwards and harming residents of the PNW communities.
Melanie	Vartanian	SEATTLE	98118	Building more parking is only going to evermore encourage people to visit SeaTac Airport by car and encourage that behavior to continue. Instead of putting so much effort into turning a local park into pavement, the Port should be working with SDOT, WSDOT, and private companies to expand transit access to the airport. Not only will it protest the current status of the park, but also reduce emissions associated with the airport.
Chris	Reye	Seatac	98168	"Big Yellow Taxi" - Counting Crows
Andrew	Gatlabayan	Seattle	98126	
kevin	su	Kirkland	98034	
Polly	Membrino	Seattle	98122	We must preserve this important public green space. This is an environmental justice issue and the trees, bog, and park space should be preserved for current and future generations. Do not develop this land.
Daniel	Sheehan-Ziter	Renton	98058	

Kathleen	Thomas	Issaquah	98027	I grew up in what is now Seatac and went to grade school at Boulevard Park Elementary. Many of my friends and their families were forced to move from the existing North Seatac Park area due to the expansion of the airport. Over the years the park has expanded and its been wonderful to see so many people taking advantage of the green space it provides. Rugby, soccer, baseball, biking just to name a few activities. The Port has already done enough damage to the area, it would be shameful for them to tear apart this community park. Please leave this green space alone!
Neil	Corkum	Seatac	98188	
Arin	Beatty	Des Moines	98198	
Vladimir	Cuko	Des Moines	98198	
Garrett	Lund	Seattle	98103	
Allegra	Sweeney	Seattle	98199	
Julie	Saelee	SeaTac	98168	
Melissa	Do	Tukwila	98188	
Heather	Fourie	Seattle	98144	
Erika	Sweet	Seattle	98144	
Nikolas	Dahl	Burien	98116	We don’t need any more parking lots.
Ryan	Rovang	Burien	98166	
Benjamin	Margolius	Bellevue	98007	
Ananda	Cooley	Seattle	98119	Please stop this ridiculously bad idea. If you need more parking buy another lot and build a parking structure, up or down. There are a vast number of environmental and societal benefits of an urban forest park and only one - profit - for a parking lot. Wake up
Kyla	Reyes	Des Moines	98198	
Troy D Williams	Williams	seattle	98107	
james	sawyers	burien	98166	never remove a park - greenspace is sacred
Kurt	Heintz	Normandy Park	98166	
Shawn	Carey	Puyallup	98373	
Michael	Nill	Seattle	98103	
bazil	hyder	Seattle	98105	
Shelby	Moen	Lake stevens	98258	

Robert	McCullough	Marysville	98270	
Penny	Thomas	SeaTac	98168	I grew up here, attending Boulevard Park Elementary, Sunset Jr. High and the former Glacier High School. Some of the primary reasons I moved back after 20 years away are the diversity, sense of community and belief that leaders here care about the quality of life created and preserved here for people of modest means. The parks, green spaces, gathering spots and recreational opportunities make this a place where families and people of all ages, incomes and abilities can thrive. North SeaTac Park is unique and precious. In a noisy, growing city, where people with few affordable options can live healthy and comfortably, the park and surrounding forested land is priceless. Please don't sell us out. Please don't destroy our community. Thank you.
Unpublished name		Normandy Park	98166	Please leave this park and surrounding area intact for the health and safety as well as the beauty of or community. Remember we vote for or against the port's board members.
Unpublished name		Burien	98166	We need more trees and less pavement. Please, stop this heinous affront to the little bit of nature remaining in our cities.
Ray	Dempsey	Seatac	98188	
Brad	Cox	Shoreline	98155	
David	Leck	Seattle	98108	
Justin	Brunson	Auburn	98092	
Pablo	Nava	Auburn	98001	
Felicia	Nelson	SEATTLE	98106	We need our trees!
Addie	Killam	Burien	98148	
Stephanie	Underwood	SeaTac	98188	
Matilda	Linden	Burien	98167	
Robert	Rice	Seattle	98136	
Dhira	Brown	Burien	98166	
Jodi	Wahoski	Burien	98166	You have taken enough of our area lands. Leave our parks alone.. PLEASE!
Nick	Giannarakis	Seattle	98104	
William	Campbell	Seattle	98043	Green spaces are valuable community goods. Let's be the leading city in the country for a reduction of car dependency. Public transit is better for high density areas like the Puget Sound.
TJ	Werle	Burien	98168	
Brandon	Dougherty	Mountlake terrace	98168	
Terri	Biermanski	Seattle (Burien)	98146	
Vivian	Ramos	Burien	98166	North SeaTac Park is a vital space for the community. It's such a privilege having this park nearby and seeing how many different people enjoy it.

Kelby	Schrock	Seattle	98321	Please preserve North Seatac Park!
Joya	Goodhue	Burien	98168	
Eric	Christensen	Buckley	98052	Don't take this park away. It's one of my favorite Cyclocross venues.
Ester	Prieto	Seatac	98122	We need the park.
Ann marie	bennett	seattle	98146	
Ashley	Stefanoff	Port Orchard	98366	Protect the park. Protect our green spaces.
Heather	Gordon-Fritz	Burien	98168	
Matthew	Tabor	Maple valley	98038	
Unpublished name		Burien	98166	We need more trees and less pavement. Please, stop this heinous affront to the little bit of nature remaining in our cities.
Unpublished name		Burien	98146	This is a forested area that is heavily used by area residents. Overall, this community has very few parks and open space. Combine this with noise and particle pollution from the airport, there is an inequity created with residents of this area being given the short end of the stick. The airport has many options to develop their land more efficiently and without damaging the forested land further. They should be required to choose a less impactful option.
Mark	Belanger	Mountlake Terrace	98043	
Katie	Riordan	Seattle	98115	
Mike	Mess	Burien	98146	
Nathan	Christman	Seattle	98106	
Shane	Massey	Burien	98168	North SeaTac Park is my Oasis away from home. I go there every day to run, walk and connect with nature. Please do not destroy the park.
Andrea	Widdison	Burien	98166	
Robert	Jones	Burien	98166	
Crystal	Nogle	Seattle	98168	
J. Lee	Cook	Polson, MT	59860	Please Port of Seattle & citizens of Seattle, King County & Washington State, listen to the many good neighborhood citizens who dearly love their unique, vivacious, unified community, North SeaTac Community. Keep the green trees of our community. To do this is 'climate friendly" and even more importantly: citizen open & welcoming. Just do the right thing for the tax payers & our families. Peace,
Aaron	Sherwood	Burien	98168	Taking away another green space that’s heavily used by the surrounding community is massively unacceptable.
Patricia	Mejia	Burien	98148	
Sara	Mendoza	Des Moines	98198	
Evelyn	Dial	Seattle	98103	
Rochelle	Flynn	BURIEN	98166	

Michelle	Kozlowski	Burien	98166	
Cathy	Hutzler	Burien	98166	
Sheenah	Randolph	Burien	98148	
Unpublished name		Seattle	98125	Keep the park for the community! Developing the park for commercial reasons doesn't serve the needs of the community for access to green space and enjoyment of nature; commercial structures don't belong in the park. We especially don't need more parking (that should be a fix for public transit instead!).
Kaylene	Wetzstein	Burien	98166	
Jacque	Riehl	Normandy Park	98166	
Meghan	Wilkins	Des Moines	98418	
Kristi	HARRISON	Burien	98148	
Leslie	Nichols-Rage	Burien	98168	This area provides pollution control needed for the community surrounding SeaTac airport. It also provides refuge for wildlife and parks and recreation for the neighboring communities.
Sianna	Ziegler	Burien	98166	
Teresa	Kaufman	Burien	98166	"Please stop this ridiculously bad idea. If you need more parking buy another lot and build a parking structure, up or down. There are a vast number of environmental and societal benefits of an urban forest park and only one - profit - for a parking lot. Wake up"
Donald	Richter	Burien	98166	
Carlyn	Roedell	Seahurst	98062	The port has gobbled up enough of our neighborhoods already. Leave North SeaTac Park alone. This neighborhood needs all of the green space it can get. Please protect what we have.
Adrienne	Banks	Seattle	98103	
Megan	Hutchison	Seattle	98117	
Robin	Macy	Seattle	98112	We need to choose the lives and health of people and the ecology of the area over business interests.
Beth	Quittman	Burien	98146	
Ryan	Blanchard	Seattle	98108	
Ali	Vrbas	Seattle	98116	
Heather	Boyes	Seattle	98146	
Stefania	Guarda	Seattle	98108	
Mark	Megarity	Renton	98058	Please!!
Maria	Metler	VASHON	98070	

Elizabeth	Florez	Burien	98166	
Molly	Pat	Burien	98148	
Giovanni	Restrepo	BURIEN	98148	
Leah	Rush	Seattle	98103	
Brandon	Stevens	Burien	98166	
Nancy Doyle	Doyle	Seattle	98146	
Lisa	Zander	White Center	98106	You will never reach your purported climate goals while also cutting down trees. Trees are literally the only way to remove carbon from our atmosphere.
Cynthia	Storch	Maple Valley	98038	
Cathy	Jackson	SeaTac	98168	
Holly	Henderson	Seattle	98122	
Trent	Fehl	Seattle	98122	
Jennifer	Walsh	Seattle	98199	
Guy	Spencer	Normandy Park	98166	King County Public Health has publicly identified the health impacts of the airport on neighbors of the airport. Given this data, it is clear that failure to preserve the remaining green spaces in favor of increased development will lead to increased negative health impacts on the community residents, and provide a bright-line proof of intentional disregard by the Port for community residents' health and lives. The liability of the Port, its elected leaders, and its contractors for the increased effect of those impacts will be crystal clear. Given KCPH documentation, class action suits will have an excellent chance of success. As well, continued tax-exempt development within the Highline School District will raise the likelihood of imposition upon the Port of a mandatory contribution toward HSD schools in lieu of the local school taxes. Currently Highline School District taxpayers pay a local school tax rate that is 240% that paid by Seattle School District taxpayers due to the extremely large percentage of real property improvements in the HSD which are tax exempt. The great majority of those exempt improvements are owned by the Port; many of them are buildings and other facilities used by private, profit-making businesses. If those buildings were not owned by the Port, they would be contributing real estate taxes to the Highline School District. Perhaps the Port will need to divest itself of those improvements and contribute land lease payments to the schools, should it wish to retain ownership of the land under the improvements.
Christopher	Fast	Seattle	98115	
Carmen	Slee	Seattle	98106	
JoAnne	Cowan	Seattle	98166	Please save this park. The trees clarify the air and the park provides green space for everyone, when it is badly needed and very rare!
Linda	Givler	Seattle	98146	

Syd	Fredrickson	Seattle	98103	
Carla	McLean	Seattle	98118	
Tammie	Lillehaug	Burien	98146	
Unpublished name		Burien (Boulevard Park)	98168	Leave our parks alone.
Megan	Cofer	Seattle	98122	
Lisa	Ramsey	Burien	98166	
Monilee	Keller	Redmond	98053	Please keep this park!!!
Phoenix	Cavalier	Burien	98168	This is about integrity, and keeping promises. Anything less is not acceptable and will not be tolerated. I hope it's clear that accountability is required and it is not okay to take more than 100 acres from a community when that land is already dedicated to compensate residents for losses incurred by prior development.
Arlene	Roth	Seattle	98126	
Gerry	Jones	Federal Way	98023	Our communities need green space and knowing the history of this park, that agreement needs to be honored.
M. Ester	Prieto	SeaTac	98168	We need the trees, not more business in the area.
Amy	Murdoch	Burien	98166	
Jason	Nguyen	Seattle	98108	We already have transit connections to the airport, including a light rail station. We really do not need more parking lots.
Tracey	Drum	Seattle	98112	I've taught in schools near and around SeaTac for 25 years and many of my students and coworkers know first hand the high incidences of cancer in this area. So many of the people of this community suffer from asthma and other illnesses made worse by pollution. Saving trees is simple and obvious, and the only humane response.
Mary	Kristen	Seattle	98126	
Jason	Dougherty	Seattle	98115	
Jackson	Gwynn	Seattle	98107	
Geri	Flynn	Seattle	98178	
William	Livernois	Seattle	98105	
Kenia	Mojarro	SeaTac	98168	
Megan	Slade	Seattle	98108	
Lena	Perry	Seattle	98144	Save the trees!
Presley	Patricelli	Seattle	98144	
Kyle	Cordell	Seattle	98144	

Sandy	Hunt	Seattle	98146	According to the science, improving the health of the area around SeaTac requires trees and undeveloped land to filter the pollution and runoff. Parks are essential to the mental health and overall well being of communities. This park is meeting the needs of the SeaTac community ecologically and physically without needing to purchase or renovate another large parcel. Land in the Seattle region is so expensive that economically it seems to me the sensible thing is to leave the area as is for the betterment of the community.
Jennifer	Bond	Maple Valley	98038	
Danielle	Camp	Maple Valley	98038	
Phoebe	Barnard (PhD)	Mt. Vernon	98273	I am signing both in organizational and individual capacities. Our papers "World Scientists' Warning of a Climate Emergency" (2019 online and 2020 in print) and "World Scientists' Warnings into Action: Local to Global" (2021 online / in print) both emphasized the strenuously avoid cutting mature trees and forests at all scales, from local plots and municipalities to global carbon and biodiversity reserves like the Amazon. As a Western Washington-based global coalition of respected and dynamic organizations collaborating to "bend the curve" on impacts on our planet, using the best and most rigorous science and deep media and public policy, planning and implementation expertise at local, regional and global levels, we strongly ask our colleagues in decision-making capacities to cancel plans to alter the SeaTac Park in any way which would reduce its important biodiversity, carbon, quality of life, air quality, recreation and noise attenuation values for our diverse local communities. Thank you!
Dominic	Petaud	New York	14817	
Janet	Munger	Seattle	98122	
Martha	De Leon	Seattle	98146	We need more parks and recreation centers not buildings.
Emily	Wilson	Seattle	98103	
Rachel	Morgan	Seattle	98103	
Lauren	Fifield	Seattle	98103	
Ryan	Sharp	Des Moines	98148	
Stacy	Hoffman	Seattle	98106	
Jesse	Starkman	Burien	98168	
Daniela	Wolfert	Seattle	98103	
Lily	Sonderlund	Cincinnati	45230	
Michael	Carver	Seattle	98106	
John	McMahon	Burien	98168	

Jill	Plourde	Burien	98168	Dear Commissioners, I can most likely provide a picture of my family enjoying every bit of this park. From BMX to the arboretum to pat ryan field. We have leisured, played, picnicked, raced and celebrated birthdays in this park. It was an escape during quarantine and still remains an outlet for our energy weekly. This park has helped solidify friendships and commit us to living where we do. It is an incredible park! Please support the efforts of the City of SeaTac to take ownership of the entirety of North SeaTac Park with strong and permanent protectiions for its recreational uses and natural resources including forested land. waterways, and Tub Lake Bog. I also urge you to ensure that the Port drops its plans to commercially develop 31 acres of North SeaTac Park and to halt its plans for commercial development of an estimated 75 additional mostly tree-covered acres in the community around the park. SeaTac, where this deforestation would take place, has one of the lowest tree canopy percentages in the county, ranking 40th out of 45 cities, according to the County's 30-Year Forest Plan. The Port must heed the recommendation of Public Health Seattle & King County to increase green space and tree coverage near the airport to reduce human exposure to deadly airport pollutants. It must honor the commitment it made as a signatory to the King County Cities Climate Collaboration to protect forests and reduce sprawl. It must honor the commitment it made to be “accountable for equitable policies” that ensure racial, social, and environmental, justice. Trees save lives. They catch deadly airport pollution and keep it out of our lungs and homes. They capture climate pollution and help stabilize our climate. They reduce flooding, cool our neighborhoods, and increase home values and economic vitality. Please act to ensure that Port staff properly value this critical infrastructure.
Michael	Matelyan	Burien	98168	Please save the North Sea tac Park Community Forest for future generations and my Grandsons especially. Thank you
Carol Virginia	Herrick	Bellingham	98229	
Nathan	O'Leary	Des Moines	98198	
Jay N.	Smith	Normandy Park	98166	
Gail A.	Smith	Normandy Park	98166	

Frances	Moralek	Langley, British Columbia	U3A458	
John	Moralek	Langley, British Columbia	U3A459	
Maurice	Godfrey	Burien	98148	
Kraig	Anderson	SeaTac	98168	please don't take away the park <3
Christopher	Fuentes	Tukwila	98188	As a Tukwila resident living near the SeaTac airport, I am greatly concerned about the decrease in our local tree canopy and the increase in pollution by the airport and surrounding development. I have considered moving away from this area for my own health but we've built such a great community and I would hate to leave the life I have created here. Both SeaTac and Tukwila are one of the most diverse cities in the area and we can't let them turn into an environmental racist area. We should be increasing green spaces, not removing them.
Craig	Cahail	Burien	98168	I love the park and the Forest around it. Please do not create parking here it is close to the only trees we have left in the area.
Amythst	Black	Normandy Park	98166	
Gerardo	Gonzalez	Burien	98166	Please preserve North and south Seatac park in its entirety, it’s the only wild green space we have left in our city, don’t destroy it don’t lay a hand on it. Future generations will thank you! Preserve North seatac park trails and rugby field, and adjacent areas. This park is the last little green patch we have left, if you turn any section of it into a parking lot it will cause a big damage to the ecosystem and the wildlife living in this area. Don’t chop the trees, this park must be preserved for future generations to come.
Sarah	Hart	Burien	98148	
Unpublished name		Seattle	98101	I urge you to do all you can to protect the people and environment in this park/area
Ronald	Osborne	Seattle	98126	Let's preserve this special green space.
James	Kime	Seattle	98116	
Patricia	Layden	SeaTac	98188	
Kurt	Maurer	SeaTac	98188	
Ted	Buchanen	Seattle	98126	The park is a mainstay in the community and supports cyclist young and old.
Janet	Kuta	SeaTac	98188	North SeaTac Park is a priceless part of our community. My family enjoys the park amenities multiple times a week all year long. Its a place for all ages of people to enjoy close to home and should stay that way. Green spaces are important for the health of our communities and I believe only other underutilized option should be considered, not green areas that makes our community a better place to live.
Christine	Emert	Des Moines	98148	
Paul	Sampson	Seattle	98146	
Unpublished name		Seattle	98168	Please leave our park alone!

Unpublished name		SeaTac	98188	I feel with the light rail and other transportations that airport parking should not take the place of our green spaces...try for more offsite areas and use of park and rides outside of Seatac...would take some coordinating with say Tukwila, Kent or Federal Way.... please look at alternative and creative ideas. Also, that whole area across from the Claim Jumber in Tukwila should be utilized better....maybe for parking...it is already cleared.
Unpublished name		Burien	98166	In 2014 I was recovering from a major leg injury. Walking the trails of North SeaTac Park was a vital part of my recovery.
Tammie	Foushe	SeaTac	98168	Please don’t let the port acquire North SeTac Park. My daughter practices soccer there every Tuesday & Saturdays which is so convenient as it’s own the street from our house. Our family utilized and loved the BMX bike track there. We were hoping they were just updating it as we see it’s no longer there. You’re wanting to take away a place that brings joy to the community to build a parking lot? Build up on what you have now & leave our parks alone!
Clayton	Compton	Bellevue	98004	
John	Kugler	Seattle	98136	
Greg	Barton	Seattle	98115	I enjoy Mountain Biking on the North Seatac Park trails. As the greater Seattle area becomes more and more built up, I find small gems like this invaluable allowing us to experience nature locally.
Coral	Covington	SeaTac	98166	Please save North SeaTac Park. My family and I love that park.
Martha	Manning	Seattle	98168	
Katy	Cooper	Burien	98168	Please don’t take this park away. It’s bad enough having to hear the airplane noise. This park brings so much joy to the community. My family walks our dogs there multiple times per week and we enjoy exploring all the trails. Home values have increased significantly in this area and more people are having to move out here since rents are too high closer to the city. Adding parking lots decreases this value.
Sandy	Shettler	Seattle	98115	In this time of climate crisis, this forest must be preserved. It is a public health benefit, providing cooling during summer, filtering air pollutants and sequestering carbon. Above all it brings the surrounding community a valuable connection to nature and joy!
Loren	McWethy	Seattle	98136	
Scott	Bly	Seattle	98116	
Sergio	Avitia	Burien	98168	This park is a staple to this community. All the land under it and surrounded should be preserved for the people who live on this area. As the port expands it should look elsewhere to fill it’s need, instead of taking this place from the families who use it on a daily basis.
Denise	Avitia	Burien	98168	Do not get rid of our park!
Rosa	Juarez	Burien	98168	Don't destroy our community by taking away anymore of our beautiful park! It is counterproductive to cut down trees and forest to add more pollution!
Alexis	Hurtado	Burien	98168	

Unpublished name		Burien	98168	This park is an incredible resource for the people of North Burien and surrounding communities. We have to deal with planes flying over our homes many times a day. This park allows us to bring back some of the mental clarity that the planes take away from our every day lives. Please do not remove any more parts of North Seatac Park for commercial or non recreational use.
Robin	Schwartz	Seatle	98108	
Lisa	Griswold	Seattle	98108	
Joel	Chapman	Burien	98168	
Unpublished name		Burien	98146	Protect our parks and trees. No asphalt.
Christina	Miller	Seattle	98108	We need green spaces!
Sya	Magee	Seattle	98168	
Ryan	Shuler	Burien	98146	Please preserve this unique a valuable resource for the future. Urban trees and green spaces are needed for the health of the population. Please think out of the box for other options than destroying this treasured piece of property for parking. This acreage is a unique multi-use forested area is used and cherished by many local citizens. Seek solutions to your parking issues elsewhere.
Joshua	Hansell	Burien	98168	It would be a crime against environmental equity to go through with a plan to destroy greenery in North Seatac Park. We already deal with increased exhaust and heavy metals from the Seatac air traffic here.
Harold	Baldwin	Seattle	98108	The Port continually puts itself out to the public as an environmentally conscious entity. If you proceed with this plan, you certainly are not. Please refrain from destroying our urban forest, as originally promised.
Solenne	Vanne	Seattle	98108	Protecting natural spaces are important for communities and the environment. I'd love to be able to enjoy the area for years to come and I hope others can too.
Dan	Hall	Seattle	98108	
Amy Kate	Horn	Seattle	98108	Southend has the worst air pollution in the city—we must preserve green space and add more tree canopy!
Gene	Church	SeaTac	98168	
Judy	Avitia-Gonzalez	Seattle	98146	My children and I enjoy this space and frequent often. It’s perfect for walking, bike riding and playing baseball. It’s one of the best local parks and exploring areas where a lot of wildlife also make their homes.
Derrick	Gallard	Burien	98168	
Liz	Liss	Seattle	98168	
Avery	Flores	Burien	98168	Please save the park! We have loved, and still do our family walks there and would be crushed to have this taken out of our neighborhood. Thanks!
Sally	Roach	Unincorporated King County	98168	This land needs to be saved in its wild state, as it is, EVERY BIT OF IT!!! I think it is atrocious and despicable that you are trying to destroy this area of trees!!!
Sagan	Lain	Seattle	98108	

Alena	Fisse-Karr	Seattle	98108	
Susan	McAliley	Seattle	98146	If I wrote to you already, it bears repeating: DO NOT CUT DOWN THESE TREES! Putting a parking lot in this area is just wrong. Find another place on property you already have. Closer to the airport. We need trees to offset pollution and all of the airline fuel being dumped on us! Thank you! On behalf of your children and all of children in this area.
Phillip	Smith	Burien	98168	I will most certainly vote against any port commissioner that tries to spoil our park.
Molly	Brashea	Seattle	98168	
Nicole	Kalda	Tukwila	98168	
Gregory	Campbell	Seattle	98108	
Stephen	Shettler	Seattle	98115	
Liam	Gleeson	Seattle	98105	
Rishi	Kavikondala	Seattle	98105	
Antyush	Bollini	Seattle	98105	
Luka	Marceta	Seattle	98040	
Joe	Zimet	Seattle	98105	
Paul	Fallon	Seattle	98105	
Ethan	Rehn	Seattle	98105	
Jordan	Kauffman	Woodinville	98072	
Evan	Foley	Seattle	98105	
Jack	Turner	Seattle	98105	
Unpublished name		Seattle	98108	Stop your greed and keep the trees. Climate change is real don't be a douche
Noah	Feinberg	Burien	98168	
Melinda	Walker	Burien	98166	If we lose these natural areas we will never get them back! We must preserve these treasured and vital areas.
Casey	Choiniere	Seattle	98106	
Colleen	West	BURIEN	98168	We need our green spaces in these urban settings for health and recreation. The Port has other options for its employee parking garage rather than ripping out this park. The people that use this park already deal with airplanes constantly flying over their homes. It's wrong to take this away.
Richard	Voget	Seattle	98103	
James	Little	Seattle	98105	
Allison	Lee-Moore	Burien	98168	Green belts in rising density areas are in great need. Please protect for the future generations and our community.
Lena	Hettler	Des Moines	98198	

Katie	Paulson	Des Moines	98198	
Claudia	Conroy	Burien	98166	The North SeaTac Park is used by so many surrounding communities. It provides an open space for bike use and trails for walking. Stop trying to minimize the access to natural outdoor space for communities of color! We deserve to keep access to this space without the constant worry that it will be destroyed to build commercial spaces or any other project.
Emily	DeTray	Burien	98166	We have a right to this green space in our community. You cannot keep taking the trees. Our health and the wellbeing of our city depends on it.
Eric	Morris	Burien	98166	
Margaret	Knasiak	Burien	98166	
Emily	Rodriguez	Seatac	98198	
Rosa	Nitchoff	Des Moines	98198	
Deborah	O'Riley	Des Moines	98198	
Cathy	Wetter	Burien	98168	
Jessica	Hester	Burien	98168	
Todd	Arney	Burien	98168	
Philippa	Webster	Seattle	98103	
Sara	Ullmer	Burien	98166	
Sarah	Butler	Burien	98168	
Sara	Hendrickson	Burien	98166	
Nikki	Bautista	Burien	98166	
Kate	Bysheim	Burien	98168	
Kirsten	Bell	Burien	98168	
Julie	Strickler	Burien	98146	
Jeremiah	Givers	Burien	98166	
Karissa	Kleps	Burien	98168	
Tory	Walker	Burien	98166	
Debbi	Altieri	Burien	98146	
Jodi	Blecksmith	Burien	98168	Find another way to get your parking
Shawna	McLean	Burien	98146	
Victoria	Andrews	Des Moines	98198	
David	Swenson	Burien	98166	
Leslie	Meekins	Normandy Park	98198	
Soph	Davenberry	Burien	98168	

Lauren	Sewell	Seattle	98102	
Ky	Magdalene	Tukwila	98168	
Andrew	Hill	Tukwila	98168	This city, more than any other I've lived in, is deafening due to airplane noise pollution. Less O2 AND more noise? Lose-Lose, friends.
Boyd	Soderquist	Normandy Park	98166	We need to save our parks and public green spaces. At a time when forest are dwindling, we need to protect as much forestland as possible!
Derek	Pells	Renton	98055	This is a top 10 country park. I've been using it sense I was a kid. These trees and green space are incredible. Why must we always lose for industry?
Corey	Elkins	Burien	98168	
Jacqueline	Casey	Kent	98032	This is highly utilized and important to keep
Jason	Jongjitirat	Burien	98146	
Barbara	Bernard	Seattle	98199	We need to preserve our tree canopy.
Michaela	Loeffler	Seattle	98126	
DOREEN	HARPER	Des Moines	98198	Leave the trees and green space and fulfill your obligation to the community by giving back to everyone surrounding it with a livable environment. What the Port of Seattle is proposing is an environmental justice issue.
Stacey	Warren	Seattle	98146	
Marc	Warren	Seattle	98146	
Maureen	Hoffmann	Burien	98166	North SeaTac Park is an essential gem to this local community, in so many ways... much of that is because of the trees and the environment they create.
Christa	Lee-Allender	Burien	98166	
Julie	Burr	Burien	98166	
Lorene	Miller	Burien	98146	
Betsy	Teays	Burien	98166	
Patricia	Paulsen	Burien	98168	
Patricia	Paulsen	Burien	98168	
Rebecca	Fino-Fugate	SeaTac	98198	
Amy	Manzo	Burien	98146	
Mike	Jones	Burien	98166	
Jennifer	Latini	Burien	98166	
Rebecca	Dedeker-Winston	Burien	98168	
Elizabeth	Tilque	Des Moines	98198	
Saundra	Mock	Des Moines	98198	Stop killing trees and humans and animals with your pollution! Stop putting Dollars OVER OUR LIVES! The trees are needed!
Kalib	Johnson	Burien	98148	

Kelly	Damey	Burien	98168	
Monica	Little	Des Moines	98198	
Matt	Mornick	Burien	98146	
Elfin	Sorenson	Burien	98146	Please care about our trees, water and land. Our earth matters!
Denise	Hemingway	Burien	98166	
Diane	Gaskill	Burien	98148	
Charles	Harris	Normandy Park	98166	The Port needs to be better stewards of the open space it controls. Far too much has been allowed to become over run by Himalayan BlackBerry, Scotch Broom and English Ivy. Let the large native trees grow and clean up the space so the forest can once again become a carbon sink to help offset port activities
Barbara	Petersen	Burien	98166	The health of the public and our planet should be a priority for everyone. Please act honorably.
Unpublished name		Burien	98168	This park is a bright spot of nature in an under-resourced part of town. The ecological and community-building opportunities afforded by the park cannot be replaced. Stop taking resources away from communities who have little to begin with.
Patricia	Phillips	Des Moines	98198	
Tamara	Chakos	SeaTac	98188	Keep North Seatac Park, perhaps develop old Tyee Golf Course
Tony	Collier	Burien	98168	Protect the Seatac wildlife in the park!!!
Laura	Hartema	Des Moines	98198	
Jessica	Dunton	Burien	98168	
Jon	Fincher	Burien	98168	
Elizabeth	Espinosa-Snow	Burien	98146	Trees are critical to the environment and our well-being. Please do your part to ensure families like mine have access to ample forested spaces.
Nancy	Rasmussen	Burien	98166	North SeaTac Park was a response to the health of the surrounding community and should not be developed for commercial use as it would be detrimental to this promise. Don't break your promise to the community for greed!
Janet	Crawford	Des Moines	98198	
Char	Sawyer	Burien	98148	Please quit removing parts of our community for your personal wealth. The Port has already done enough damage to the area. Build airports elsewhere rather than continuing to expand S.T.I.A. Trees cut down on not just pollution, but help mitigate noise.
Nick	Desanti	SeaTac	98188	
Lorraine	Chachere	Kent	98032	
Mark	Landsaat	Burien	98166	
Jennifer	Kropack	Des Moines	98198	Bad idea in light of the public benefit and the need for climate change relief! A tree lover, a clean air, shade lover, and nature lover too.
Ian	Gunsul	Burien	98166	

Unpublished name		Burien	98166	North SeaTac park is a beloved part of the SeaTac and surrounding communities. There is no argument for development other than profit. While there are other green areas in neighboring communities, the North SeaTac area serves a racially, ethnically, and economically diverse community. To take away such a resource is a disservice and a disgrace. Additionally, people from all over King County come to North SeaTac park to enjoy the trails and community found among the varied activities - hiking, mountain biking, running, walking - available within its boundaries. 31 acres of 107 is 31 too many. Find your financial resources elsewhere.
Unpublished name		Des Moines	98198	Please do the job you swore you would do.
Michelle	Dangol	Seattle	98168	Not to mention the old growth tree canopy helps protects against the noise from the planes which get noisier and lower to the ground every day. And they want to take away the one thing that helps us deal with their already overwhelming impacts!!
Daniel	OBrien	Burien	98166	
Nancy	Brown	Des Moines	98198	Do not cut down trees that are so important to our community.
Megan	Clark	Burien	98146	
Courtney	Lemus	Des Moines	98198	
Daniel	Wend	SeaTac	98198	
Anna	Simon	Normandy Park	98166	There are so few parks and places to run in this area already. Please prioritize green space for the health of our local communities.
Jessamyn	Hager	SEATTLE	98168	
Amy	Truax	SeaTac	98198	
Karin	Ellis	SeaTav	98198	
Patti	Davies	Burien	98166	
Gwen	House	Des Moines	98198	Save the trees! Save the park!
Trifin	Sergieff	Des Moines	98198	Just build another airport somewhere else instead of destroying our community little by little
Unpublished name		Burien	98168	Hands off our public green spaces!!!!! I and many others explicitly voted for you because I believed you have the best interests of the community. Don't let us down. Keep your hands off our public green spaces!
Terri	Benish	Des Moines	98198	
Natalia	Fialkoff	Burien	98166	Leave our park alone. We need the fresh air due to the airport and have very few parks.
April	Carson	Tukwila	98178	This idea is unconscionable!
Danielle	Blick	SeaTac	98122	
Rebecca	Rider	SeaTac	98168	Please save our parks and trees for our future.I see a lot of new building in this area as well with not much care for tree loss. I believe our area can be a showcase for how to improve our area and better our area.

Sara	Bent	Burien	98168	Leave our forest alone! We need our trees vital to the quality of life we live
Ryan	Nielcen	Burien	98148	
Elizabeth	Taylor	Des Moines	98198	
Mamie	Sevores	Des Moines	98198	
Andrea	Conver	Burien	98166	
Liz	Sanborn	Des Moines	98198	
Karen	Therese	Seattle	98106	
Beverly	Walker	Des Moines	98198	Stop taking down the trees.
Amy	Hitchens	Des Moines	98148	I grew up in Boulevard Park and remember the neighborhoods that existed before the port bought out all the homes. The promise of a park and green space was made. That promise needs to be kept. With all the CO2 emissions from the planes, we need every last tree we have got. It can take 100 years to replace a mature tree. Green space is precious. Parking lots, cement and expansion for expansion sake is not. It's also well documented that neighborhoods with too few trees are hotter and less hospitable to humans. Asthma is worse. All the problems that are inherent to living close to a major airport are worse. Please save the greenspace.
Amy	France	Des Moines	98198	
Cameron	Carl	Des Mones	98198	
Susan	Woltz	Burien	98166	We must protect the environment NOW
Kathy	Hazen	Seattle	98136	I have been going to North SeaTac Park for over 40 years. With the airport so close and the pollution it causes, plus the pollution from vehicle exhaust, we need to keep as many trees as possible in the area. This is also a great park for recreation in many forms. Please keep North SeaTac Park whole for the good of all of our local communities.
Ronald	DeShayes	Seattle	98168	
Karen	Spence	Seattle	98115	
Unpublishd name		Port Townsend	98368	I fly from SeaTac, I lived in burien and now in p townsend. This is a ecological and city health issue to keep this park and these trees.
Cindy	Prescott	Kent	98031	
Rachael	Reedal	Maple Valley	98038	save the trails
Desiree Rose	Fagan	University Place	98466	
Behnosh	Najafi	Seattle	98118	Forests are vital to cleaning our air, which is particularly important for S Seattle residents. Please do not develop this beautiful area. We need more green spaces, not more development!
Debra	Valpey	Normandy Park	98166	People are more important than parking spaces.
Carol	Huddleston	SeaTac	98168	North SeaTac Park is a popular and well-used public space - please keep it!

Leslie	HIner	SeaTac	98168	We need our green space. Once the big trees are gone they can won't be replaced. Our children and grandchildren deserve to have clean air and water.
LIsa	Zander	Seattle	98106	You cannot meet your stated goals for sustainability and equity while harming the trees in this park. These two things are at odds with each other. Take a stand for a livable planet and preserve North SeaTac Park!
Elaine	Moy	Seattle	98136	
Michael	Hecklinger	Seattle	98118	
Luke	McPhee	Des Moines	98198	
John	Whiting	SeaTac	98168	
Robert	Mackey	Black Diamond	98010	
Evan	Ruiz	Maple Valley	98038	
Mekdes	Kissi	Tukwila	98168	
Carmen	Garza	Burien	98168	This park is my family's favorite and would be missed. I live in a near by apartment so I don't have anywhere to walk and this has been a familiar and safe place for me to come and enjoy.
Mary	Escajeda	Burien	98168	Leave North Seatac Park alone! We the people of the community love the park and want to keep it.
Laird	Vernon	Des Moines	98198	
Dorothy	Gesick	Seattle	98136	We need a tree canopy if we are to combat climate change
Josh	Wilmot	Burien	98146	The 200 acres of wilderness that are at risk of being cut down represent critical greenspace for our region and further help to remediate pollution. Removing these trees is an act of environmental injustice, and will directly affect the quality of lives of those who live near the to airport, many of whom are either low income and or people of color.
Katherine	Woolverton	Seattle	98106	
Grace	Maxine	Burien	98166	Don't bulldoze my favorite park! We have enough parking lots!
Matt	Martin	Seattle	98107	
Gabriel	Ball	SeaTac	98168	Do not destroy our woods deforestation is already a problem in many places and the last thing we need is to hack down more. The planet is dying because of things just like this.
Unpublished name		Seattle	98108	Please don't take this park down this is one of the parks that I feel safe bring my family here, the garden is so beautiful!
Morigon	Blacktongue	Spokane	99224	
Chris	Davidson	Des Moines	98198	Save nature and the trees build your parking somewhere else.

Linda	Golley	Kent	98032	I used to live close to the airport, and many of my friends live there now. Now I live in Kent but my family enjoys the natural parks and spaces in Des Moines and Seatac as well. Everyone I know wants to keep the trees we have plus natural areas. Please use already destroyed land in the huge cemented-over areas of Kent if you want to build more warehouse and factories. Don't destroy the little natural land we have left.
Matthew	Chapman	Tacoma	98405	Save our parks before they are all gone!!
Vicotoria	Vietze	Seattle	98168	
Aidan	Maxwell	Aurora, CO	80014	This forest is a treasure to the community around it and it is more important to our wellbeing and health than words could express.
Quixote	Vassilakis	Bronx, NY	10463	
Ozias	Goodwin	Seattle	98118	Decisions regarding land use, must be useful for our generation and future generations.
T'Kope	Steiner	Bellevue	98005	We have enough parking lots.
Colleen	Hinton	Burien	98166	To my mind, there is just no debate as to whether we should save every tree we possibly can, given the threats that climate change are posing. Please do the right thing here. Preserving our forests is essential to combating greenhouse gases. Act before it's too late.
Aidan	Arkanit	SeaTac	98188	
Ronald	DeShayes	Seattle	98168	We are losing way too many trees and that is bad for our environment. This park is very important for families and friends. BIG BUSINESS must not step on us. This is our park. They have other property to chose from!!!!
Steven	O'Kelley	Seattle	98168	
Nichole	Reich	Burien	98166	We love this park, me & both of my children have do many memories of wonderful times exploring to beautiful wooded area & we would be heartbroken to see it turned into anything else.
Jackie	Peez	Burien	98166	We need many more trees and parks. Warehouse's and parking lots can go under ground on property already owned by the Port. Doing what is cheep for you is wrong for the people and the earth.
Steve	McVay	Burien	98168	
Debbie	Neely	Burien	98166	
Amy	Benson	SeaTac	98168	
Gerald	Gonzalez	Buien	98148	
Inga	Isakson	Burien	98168	Just do the right thing……save this tiny piece of trees for the future.
Jackson	McFadden	Burien	98146	
Colleen	Stephens	West Seattle	98136	Please defend the remaining green space in a densely industrial area. It gets greatly used by families, cyclists, dog walkers. We enjoy that park!
Leonard	Dosono	SeaTac	98188	
Jessica	Wood	Burien	98166	

Unpublished name		Burien	98168	This park needs to be saved. It is a home to many different animals. It is used by our community and children enjoy the park life and woodsy adventures. Walking in the woods on the trails and learn about the animals and their habitats.
Julie	Dosono	SeaTac	98188	Leave North Seatac Park alone
Michael	Stevenson	Burien	98168	
Heather	Diepenbrock	Burien	98168	
Emory	Christenson	Burien	98168	
Danielle	Stevenson	Burien	98168	Please, don't make us suffer the loss of our green areas and trees for profit. We need them for our health. Physical and mental.
Shelli	Park	Burien	98166	
Sawyer	Stolz	Renton	98055	Protect what little natural area we have left!
Emily	Wilson	Seattle	98103	
Lacey	Peterson	Burien	98166	
Ashley	Cea	SeaTac	98168	
Katie	Cea	SeaTac	98168	
Mary	Wieckowicz	Burien	98168	Keeping the trees is the least you can do to help mitigate the ever increasing noise and emissions we experience. Life around the airport is becoming unbearable
Jason	Quackenbush	SeaTac	98188	
Anthony	Gazzillo	Hellertown	18055	
Catherine	Richards	Seattle	98146	
Christopher	Marchitto	Seattle	98168	
Siavao	Pousima	Kent	98031	
Amaya	Vili	Federal Way	98003	
Letavia	Laga	Federal Way	98003	
McKay	Marin	Des Moines	98198	
Orly	Statlander	Seattle	98168	
Mohamed	Moalim	Seattle	98178	
Abdirahman	Tache	Tacoma	98422	
Alinur	Golicha	Seattle	98126	
Aden	Issaq	Kent	98032	
Nurow	Edo	Auburn	98001	
Shino	Aden	Renton	98055	
Isaq	Ifre	Seattle	98118	
Abdinur	Hussein	Tukwila	98188	

Zakariya	Abdi	Tukwila	98168	
Ibrahim	Haji-Eda	Seattle	98118	
Isaq	Moahim	Seattle	98108	
Hassan	Edam	Seattle	98128	
Maryan	Edin	Seattle	98118	
Juwayriya	Hasan	Seattle	98118	
Shamso	Saeed	Renton	98055	
Nasra	Bulle	SeaTac	98188	
Yasmine	Pousima	Kent	98031	
Tualiagi	Pousima	Kent	98031	
Valo	Pousima	Kent	98031	
Siavao	Agemotu	Kent	98031	
Jason	Mataituli	Des Moines	98198	
Angela	Schvaneveldt	Burien	98168	
Jean	Villamizar	Seattle	98168	
Arlen	Vargas	Seattle	98168	
Tiffany	Crosby	Burien	98166	
Jeanne	Bartlemay	Bellevue	98006	
Clara	Gilbertson	Burien	98166	
Jerda	Benson	Tacoma	98443	
Tiffany	Woods-Long	Tukwila	98168	
Maureen	Hoffman	Burien	98166	
Andrea	Vasilieff	SeaTac	98188	
Lily	Flentje	Burien	98166	
Carol	Lay	Burien	98166	
DJ	Nhem	Burien	98166	
Oeun	Nhem	Burien	98166	
Emma	Freeman	Burien	98166	
Maia	Schinkel	West Seattle	98106	
Allison	Preisinger	West Seattle	98116	
Kaylah	Garcia	West Seattle	98146	
Ivan	Barylsky	Burien	98166	
Amy	Barton	Normandy Park	98148	

Rashmi	Koushik	Burien	98168	
Chloe	McDougall	Burien	98166	
Jordan	Sharp	Burien	98166	
David	Wilson	Normandy Park	98166	
Steve	Hewes	Burien	98148	
Elizabeth	Norton	Burien	98168	
Francine	Norton	White Center	98106	
Scott	Norton	White Center	98106	
David	Dunbar	Burien	98168	
Tony	Dodge	Burien	98146	
Sheil	Dodge	Burien	98146	
Lucille	Palmere	Burien	98166	
Gabe	Mose	Des Moines	98198	
Diane	Zell	Auburn	98092	
Sarah	Mariesh Berger	Seattle	98136	
Ben	Berger	Seattle	98136	
Emily	Crain	Seattle	98106	
Judith	Cullen	SeaTac	98188	
Ash	Wagner	Burien	98168	
Paul	Wagner	Burien	98168	
Raymond	Chinn	Burien	98166	
Anna	Jowell	Shoreline	98155	
Mason	McCafferty	Seattle	98105	
Ollivia	Morrison	Burien	98166	
Unpublished name		Seattle	98115	trees are crucial to quality of life and health! especially crucial next to heat islands like SeaTac/airports
Carol	Morrison	Burien	98166	
Zulfa	Jupic	Tukwila	98168	
Mehrudin	Jupic	Tukwila	98168	
Sydney	Elicker	Tukwila	98188	
Anna	Skey	Burien	98166	
Nicole	Taylor	Burien	98148	
Haylee	Conn	Burien	98148	

Lily	Veal	Burien	98148	
Marsha	Ritter	SeaTac	98168	
Christine	Erikson	Burien	98166	
Alice	Salter	White Center	98146	
Jeanne	Salter	Burien	98166	
Ellen	Miller	Burien	98168	
Kim	Sandler	Burien	98166	
Reed	Christian	Burien	98166	
Holt	George	Issaquah	98027	
Joyce	Wahito	Kent	98030	
Ari	Elliot	Everett	98204	
Yashika	Kachana	Renton	98055	
Julie	Martinez	Renton	98058	
Sophea	Martinez	Renton	98058	
Ana	Salinas	Burien	98166	
Rance	Arnold	Burien	98166	
Stacy	Tuininga	Issaquah	98059	
Sharon	Kelly-Shaw	Federal Way	98023	
Zeke	Spier	Burien	98146	
Sue	Kim	Burien	98146	
Barb	Thomas	Seattle	98126	
Launi	Paris	Kent	98032	
Stephanie	Ruiz	Des Moines	98198	
Renee	Post	Seattle	98106	
David	Gielozyk	Burien	98146	
Sandy	Ferrin	West Seattle	98116	
Dana	Ferrin	West Seattle	98116	
Hannah	Mekonen	Burien	98148	
Sarah	Eymul	Burien	98166	
Helen	Weise	Normandy Park	98166	
Joy	Villaruz	Kent	98042	
Pamela	Brossard	West Seattle	98136	
Barbara	DeVincentis	Burien	98166	

Susan	Mitzel	Burien	98146	
Areli	Vicona	Tukwila	98168	
Maria	Montaig	Tukwila	98168	
Sallie	Farafantoff	Burien	98148	
Kathryn	Robinson	Seattle	98112	Think about the future, about the people. Do the right thing please.
Kari	Connor	Seattle	98144	
Karin	Hirschfield	Seattle	98144	
Ann	Muno	Seattle	98122	
Shalom	Kilcup	Burien	98168	Our family utilizes North SeaTac park regularly for fun, exercise and relaxation. It's vital to this community and provides green space to many who do not have a yard at their residence. The park is so well taken care of and clean. Please let the people of our community keep this special place to gather.
Tim	Franz	Burien	98168	North Seatac Park is a great place for many people in our community. I regularly ride my bike there, as well as play disc golf, and walk the dog. The South end of it, which is mostly a natural area with trails is a fun place to mountain bike and explore. We, as a community should keep it that way.
Vivian	Korneliussen	Shoreline	98133	As a K4C city, Seattle needs to protect parks and forested areas. Seattle has also agreed to uphold Diversity, Equity and Inclusion (DEI), and the first free in that is protecting the trees that absorb carbons, produce oxygen, cleans water by transpiration, cools neighborhoods and helps the mental health of the community. Let's protect this park that is so important to this community, which already faces adversity by being so close to an airport.
Lauren	Frederick	Des Moines	98198	Please make a written commitment not to develop North SeaTac Park, and to preserve and protect it in its entirety for perpetuity. The loss of green space and pollution caused by the Port over decades have caused great harm to airport communities. I have seen this firsthand as a lifelong resident of airport communities. Committing to preserving this park will be a step toward addressing these harms.
Quixote	Vassilakis	Bronx, NY	10463	Please leave the trees where they are!
Riley	DeLora	Seattle	98108	
Tammy	Haney	Burien	98168	North Seatac Park is going to sustain our way of living. All the other area is industrial and many trees have already been removed in & around Des Moines Memorial Drive. I am a home owner in Boulevard Park and have been in the same home for over 20 years. We need to have some trees to sustain what little wild life we still have. We need shade as our temperatures continue to rise in the summer. Please leave the park and surround area with the trees!
Isabelle	Feraudo	Seattle	98103	
Geoff	Simpson	Seattle	98115	

Ali	Bigliardi	SeaTac	98198	As new members of this community, the parks surrounding our home are our favorite, most valued aspect of living here. The community parks of SeaTac have made living in the flight path and near to the traffic of the airport manageable and even enjoyable! Without these parks, I fear this area and the community surrounding it will be threatened and less desirable places to reside. Please keep our parks! Thanks for your time.
Tayissa	Gabreski	Burien	98168	
Nancy	Corr	Des Moines	98198	
Hannah	Whobrey	Seattle	98105	Go parks!!! No airport expansion!
Marie	Sanchez	Seattle	98168	Please leave our park alone.
Ella	Garnett	New York	10580	
Talia	Moris	Seattle	98105	
Alaire	Kanes	Rye, NY	10580	
Piper	Laak	Seattle	98112	
Carla	Rogers	West Seattle	98146	
Steven	Butts	Seattle	98168	
George	Avery	Burien	98168	
Eva	Avery	Burien	98168	
Chris	Canfield	Seattle	98168	
Alana	Isenhour	SeaTac	98168	
Colleen	Thomas Reitsma	Renton	98058	
Lola	Reitsma	Renton	98105	
ZsaZsa	Floyd	Kent	98030	
Rose	Winterhalder	Burien	98168	
Kevin	Power	Seattle	98168	
Karen	Veloria	Burien	98168	
Omar	Hernandez	Burien	98168	
Chad	Mall	Burien	98168	
Jeanne	Salter	Burien	98146	
Christian	Ellerbee	Burien	98168	
Grace	Ellerbee	Burien	98168	
Tiffany	Hatch	Burien	98168	
Glovina	Albrecht	Burien	98168	
Margaret	Carlisle	Burien	98168	
Jim	Carlisle	Burien	98168	

Floyd	Reitsma	Renton	98058	
Rochelle	Miller	Normandy Park	98166	
Mary Jo	Winther	SeaTac	98186	
Diane	Kennish	SeaTac	98188	
Elizabeth	Reisner	Seattle	98118	
Jade	Jost	Seattle	98144	
Kristin	Tregillis	Seattle	98144	
Triniti	Gorbunova	Bellevue	98005	
Kristina	Chu	Seattle	98126	
Carol	Porth	Mountlake Terrace	98043	
Nancy	Maranville	Seattle	98115	
Ali	Lee	Seattle	98103	
Aysah	Jacob	Seattle	98108	
Shawneequa	Sessom	Seattle	98122	
Christa	Erwin	Seattle	98144	
Anthony	Dang	Bellevue	98008	
Angela	Lewis	Everett	98208	
Laura	Wood	Seattle	98122	
Daniel	Hannah	Seattle	98118	
Jeri	Sonsteng	Seattle	98118	
Rishikanta	Pukhrambam	Seattle	98118	
Keith	Ervin	Seattle	98115	
Alycia	Peterson	Seattle	98144	
Valerie	Bank	Seattle	98118	
Steve	Nickison	Seattle	98118	
Falisha	Kurji	Seattle	98122	
KL	Shannon	Seattle	98122	
Bill	Sampson	Seattle	98115	
Ken	Zirinsky	Tacoma	98407	
Saphronia	Young	Federal Way	98003	
Ben	Pfeiffer	Seattle	98115	
Hannah	Wilems	Sammamish	98074	
Terri	Dayton	Kirkland	98034	

Andrew	Turgeon	Seattle	98122	
Carol	Thomas	Seattle	98118	
Alice	Fong	Lakewood	98498	
Flora	Lewis	Seattle	98118	
Neshia	Alaovae	Seattle	98118	
Blake	Thompson	Seattle	98118	
Bruce	Lee	Kent	98031	
Basim	Mohammed	Seattle	98118	
Christa	Erwin	Seattle	98144	
Patricia	Mejia	Burien	98148	
Maritza	Lauriano Ortega	Everett	98204	
Mona	Lee	Seattle	98118	
john	roderick	Normandy park	98166	
Robin	Haguewood	Burien	98168	
Romana	Vasyleha	Seattle	98105	
Stefanie	Berg	Burien	98166	
Annette	Anderson	Burien	98166	
Rosemary	Warren	Seattle	98106	
Harold"Butch"	Henderson	Burien	98168	We must keep this as a Park.
Maritza	Lauriano Ortega	Everett	98204	
Marjorie	McKinney	Normandy Park	98166	Honor your commitments to our communities and to this land. Save the trees! We are being subjected to your poisons. Stop! Do it for the children!
Douglas	Clark	Normandy Park	98148	Don't destroy our precious natural legacy
Andrew	Mitzel	Burien	98146	
Cathy	Hutzler	Burien	98166	
Amy	Hitchens	Des Moines	98148	I grew up in Boulevard Park and remember when this park was created after the housing development was removed by the Port. It is well documented that lower income areas are hotter in the summer due to a lack of trees. Climate change is now. Scorching summers is now. South King County and especially the area around and near the airport absolutely needs its trees to offset the horrible jet engine pollution that we are all subject to as neighbors to the airport. The least the Port could do is provide the community with guaranteed greenspace that is regularly enjoyed by the community. Truly we do not need another parking lot or another warehouse serving the Port.
Jon	Burien	Fincher	98168	

Theresa	Burien	Lopez	98146	The surrounding areas have already been overexploited. Please put your community over profit.
Erik	Burien	Gilje	98148	
Mike	Normandy Park	Closson	98166	
Cassandra	Braget	SeaTac	98188	
Kathleen	Dunn	Seattle	98166	
Lori	Garcia	SeaTac	98168	
Katherine	Steen	Burien	98168	
Frederick	Kleist	SeaTac	98168	
Melissa	Phung	Woodinville	98077	Thank you for your service
Jenn	Greenstein	Burien	98166	This is a social justice and racial justice issue as taking from the park will most impact health and quality of life for BIPOC community members. Preserve this climate and airport mitigation and protection for all!
Theresa	Costinett	Burien	98166	
Ury	Salinas	Burien	98166	
James	Stilts	Burien	98166	
Caitlyn	Jarecki	Burien	98126	
Freddie	Fanning	Burien	98166	
Kathy	Olijar	Des Moines	98198	
Kamal	Sidhu	Puyallup	98372	
Lavinia	Maes	Burien	98166	
Cheryl	Esslinger	SeaTac	98188	
Patrick	Esslinger	SeaTac	98188	
Daniel	Smith	Burien	98166	
Terrance	Jorgensen	Burien	98146	
Robert	Walton	Burien	98168	
Namiko	Layden	Seattle	98103	
Mymuna	Sidibé	Tukwila	98188	
Suji	akai	Normandy Park	98166	
Fred	Fullerton	Burien	98148	
Austin	Bias	Burien	98166	
Karen	Brady Smith	Kent	98032	
Dan	Waingrow	Normandy Park	98166	
Mikayla	Stone	Burien	98148	

Kurt	Hansen	SeaTac	98188	
Dan	Flick	Burien	98816	
Thomas	TRUE	Normandy Park	98166	
Tracey	Bernal	Seattle	98146	
Joe	Kornowske	Covington	98042	
Jennifer	Reck-Allen	Seattle	98146	
Caroline	Mclaughlie	Renton	98058	
Alicia	Pavey	Burien	98148	
Richard	Hoberecht	Tukwila	98188	
Jean	Held	Des Moines	98198	
John	Held	Des Moines	98198	
Christi	Sifri	Seattle	98136	
Lynn	Rody	Burien	98166	
Inghram	Jena	Burien	98168	
Timothy	Rody	Burien	98166	
Timothy	Layden	SeaTac	98188	
Monica	Mulligan	Seattle	98146	
Nicola	Whaley	Burien	98166	
Laura	Waingrow	Tacoma	98244	
Jasmine	Jenkins	Burien	98166	
Renee	Phelps	Seattle	98126	
Stacy	Plaisara	Normandy Park	98166	
Pete	Rodriguez	Yakima	98002	
Josue	Subuyuj	Kent	98031	
Nathaniel	Mouhanna	Woodinville	98072	
Wintana	Dawit	SeaTac	98166	
Elizabeth	Seelye	Seattle	98146	
Adam	Fenerty	Burien	98166	
Richard	Rosenthal	Seattle	98146	
Elizabeth	Burton	Seattle	98103	
Elizabeth	Hoekstra	Tukwila	98168	
Megan	Steindorf	Seattle	98146	
Ana B	Contreras	SeaTac	98168	

Kristina	Nicchi	Seattle	98146	
Unpublished		Burien	98168	Keep the park and please stop cut trees . keep the parks safe . go look for other options for you parking.
Vanessa	Brogan	Normandy Park	98166	
Jeannine	Scott	Mamaroneck	10543	
Christine	Gibbs	Burien	98168	
Brandon	Kitts	Burien	98168	Parks and trees are necessary and important to our community.
Ashok	Mulholkar	Seattle	98108	
Unpublished		SeaTac	98198	I live below 3rd runway. I live with constant noise and polluted air. Seatac needs every tree and green space. North SeaTac park is a valuable park where community gathers. Please give this park to citizens of SeaTac!
Peggy	Printz	Seattle	98115	Please protect the trees! So little forest is left in our area, we need to preserve habitat and shady spaces.
Samantha	Bennett	Seattle	98108	I have only recently discovered this park. It is the best park I have been to. It should remain as a park, if anything it should be expanded!
Michelle	Dangol	Seattle	98168	
Mikel	Orsborn	Burien	98168	
Jorge	Garcia	SeaTac	98168	
Raymond	Valpey	Normandy Park	98166	
Karla	Hernandez	Federal Way	98023	
Ron	Stanek	Boulevard Park	98168	
Randy	Wiser	Seattle	98108	
Cynthia	Howell	Seattle	98168	
Kimberly	LeRoy	Burien	98168	
Caleb	Lee	Burien	98168	
Jose	Santos	Burien	98168	
Kendra	Wight	Seattle	98108	
Tinnia	Faaumu	SeaTac	98188	
Taz	Maile	SeaTac	98168	
Craig	Anderson	Seattle	98118	
Linda	Anderson	Seattle	98118	
Amber	Brown	Seattle	98118	
Theresa	O'Brien	Burien	98168	
Max	Hutton	Seattle	98108	
Gilbert	Loa	Burien	98166	

Kate	De Carrillo	Burien	98168	
Cheryl	Eastberg	Seattle	98118	Strongly against taking of parkland! Parks are not "free available land", instead they are their highest and best use for quality of life and environment, especially in this area impacted by the agency now wanting to impact further.
Angus	Scott	Mamaroneck, NY	10543	
Geoff	Miller	Seattle	98168	
Zachary	Kirshbaum	Seattle	98103	During this urgent time, you are some of the few people who have actual power to create change. Stay on the side of nature and the people in the areas you represent, and protect what we have left.
Nina	Saechao	Burien	98146	
Viola	Brumbaugh	Burien	98146	
Hana	Crumley	Burien	98168	
Simarjeet	Malhi	Renton	98058	
Christian	Poulson	Seattle	98108	Communities in the area deserve continuous engagement on this issue from the Port and should have a role in decision making re: North Seatac Park
Katelyn	Kinn	Bremerton	98312	
Susan	Ward	Seattle	98133	
Geetha	Fink	Burien	98166	
Andrew	Fink	Burien	98166	
Breanna	Shove	Burien	98166	
Scotland	Schieber	Burien	98166	
Jay	Edgerton	Renton	98058	
Liam	Carter	Burien	98166	
Vivian	Chan	Burien	98166	
Andrew	Forbes	Burien	98136	
Skye	Singleton	Kent	98032	
Drew	de Vry	Burien	98148	
Rohit	Eustace	Des Moines	98198	
Melissa	Topscher	Des Moines	98198	
Kaylin	Cochran	Burien	98168	
Sean	Place	Burien	98168	
Dorothy	Dahl	Burien	98166	
Tim	Klotz	Olympia	98501	
Brendan	D'Ambrosio	Burien	98166	

Vic	Rajan	Burien	981??	
Jud	Ketuirtis	Des Moines	98198	
Matt	Lyman	Burien	98166	
Emily	Acquino	Burien	98146	
Olivia	Jacques	Burien	98166	
Niamh	O'Rourke	Burien	98166	
Amy	Friedman	Burien	98146	
Ellen	Engberg	Normandy Park	98166	
Kimberly	Graves	Seattle	98146	
Josh	Graves	Seattle	98146	
Colin	Petkus	Burien	98166	
Dan	Satterberg	Normandy Park	98198	
David	Newsom	Burien	98166	
Elliott	Newsom	Burien	98166	
Kayla	Loy	Burien	98166	
Lory	Newsom	Burien	98166	
Linda	Norman	Normandy Park	98198	
Benjamin	Scheiner	Issaquah	98029	
Kara	Erickson	Burien	98166	
Casey	Jeannot	Seattle	98116	
Teo	Mannino	Seattle	98112	
Paul	Mannino	Seattle	98112	
Kenneth	Sheedy	Seattle	98178	
Jesse	Licht	Normandy Park	98166	
Molly	Tolletson	Normandy Park	98166	
Jason	Williamson	Burien	98168	
Jennifer	Strechler	Seattle	98118	
Brooke	Strechler	Seattle	98118	
Jafar	Ila	Seattle	98107	
Kristen	Uhring	Seattle	98146	
Lisa	Ritchie	Bellevue	98005	
Robin	Engle	Burien	98168	
Patrick	McKee	Mercer Island	98040	

Matthew	Mason	Bothell	98021	
Alex	Weber	Seattle	98125	
Will	Feury	Seattle	98102	
Gian	Rosario	Seattle	98118	
Melissa	Link	Kent	98032	stop master plan developments.
Ronald	Wisner	Kent	98032	no destruction of our trees and beautiful lands just to make a parking lot
Ericka	Berg	Seattle	98133	
John	Fawcett-Long	Seattle	98136	I drive very senior members of Burien, Sea-Tac, and Des Moines by this park frequently as a driver for the Providence Elderplace program. Removing or reducing this green space would certainly diminish their lives and mine as well. We also need this space to address climate change as well.
Lindy	Laurence	SeaTac	98198	
Charlie	Sikes	Seattle	98105	
Aubrey	Wisdom	Seattle	98105	
Montgomery	Robertson	SeaTac	98198	I did a literary journalism paper on the park for a Senior English assignment, and I learned so much about the park that I didn't know before. Before I wrote my paper, I knew only a few tidbits Noemie Maxwell told me during volunteer events, but I have discovered a huge injustice through my research. I believe, that not only does the Port need to legally make the park a park forever, but they should let the city of SeaTac buy it, for just as cheap as the Port got it in the 80s. We cannot allow the park to stay with the Port, or let it fall into private ownership. SeaTac has proven time and time again that they protect and defend green spaces, while the port has paved over them the first chance they get. They will do the same with North SeaTac Park. Here is a viewing link to my paper: https://docs.google.com/document/d/18Eyw5Rg7S9TfcbvJ4zbaK1dpcVUl_nuvxMsKXUlv9mc/edit?usp=sharing
Nicholas	Robertson	SeaTac	98198	
Edward	Walsh	Renton	95055	
Jared	Howe	Seattle	98108	
Katelyn	Saechao	Seattle	98178	
Kayley	Pingeon	Seattle	98122	
David	Lin	Seattle	98105	
Liane	Clemen	Seattle	98115	

Brad	Street	Seattle	98118	
Steve	Zemke	Seattle	98133	Permanently Protect North SeaTAC Park. Thank you.
Elizabeth	Burn	Des Moines	98198	Preserving our green spaces is of utmost importance for the health of the planet
Karl	Pauls	Seattle	98102	
Scott	Romine	White Center	98106	
Alex	Gouras	Normandy Park	98148	
Edward	Walsh	Renton	95055	
Natalie	Rivera	Kent	98042	
Eesha	Jain	Bellevue	98008	
Julia	Wang	Bellevue	98006	
Jeffrey	Luo	Bellevue	98006	
Eugene	Li	Bellevue	98006	
Rohit	Venkatesan	Sammamish	98074	
Calvin	Zhang	Clyde Hill	98004	
Alexander	Bonev	Bellevue	98006	
Brian	Russell	Normandy Park	98166	
Emily	Hitchens	Des Moines	98198	Groups of trees actually lower the outside temperature. (This is based on research from the the Nature Conservancy study at the Ellsworth Preserve and others.) while asphalt increases it.
John	DeVos	Burien	98168	
Stacie	Latimer	Burien	98166	Thank you for reading these responses. Each has a big heart and a very concerned voter behind it. At a time when cities, including Burien, are tightening up tree cutting policies...recognizing the critical value of trees and green space to humans, animals, and a troubled planet...would not be the same time you take huge numbers of trees down. We need trees. Recent research shows they need each other. Animals dependent on them need us to do the right thing. Please understand the urgency here -and leave those lovely stands of trees alone.
Elizabeth	Greninger	SeaTac	98188	
Quynhngoc	Nguyen	SeaTac	98168	
Derek	Beauchemin	SeaTac	98168	
Stephanie	Booth	SeaTac	98188	
Jennie	Lee	SeaTac	98168	
Susan	Woolworth	SeaTac	98168	Stop cutting down trees! !

Racheal	Jobe Cuba	Tukwila	98168	Trees reduce air pollution and wind, provide safe places for birds and small animals to live, and create much needed shade in our increasingly warm summers. The forest provides a home for larger animals that have already been displaced by our ever growing communities. Please leave the trees be and preserve our shock of nature in this otherwise urban landscape.
Jed	Doyle	Burien	98168	We're gonna keep fighting this. We're gonna spread awareness. The ports reckless pursuit is going to get exposed. Protect the bog, protect the animals, protect our air and reduce noise pollution..... Oppose the port of Seattle. They are inhumane.
Andrew	Bleeker	Burien	98166	
Holly	Halter	Burien	98168	I live next to this park and to cut these trees would be criminal. Save this park for my children
Rachel	Bjork	Seattle	98103	
Jimmy	Brown	SeaTac	98188	Please protect these forested areas, it is the main source of outdoor recreation for my family. I would feel a strong desire to move if these spaces are removed
Krystal	Marx	Burien		Living near a major airport should not be synonymous with environmental degradation. The preservation of our green spaces and local habitat should be top of mind when considering how to best serve the communities that surround Sea-Tac International Airport.
Lori	Lucky	Des Moines	98198	
Allison	Klecan	Seattle	98108	
Scout	Parda	SeaTac	98188	
Kathryn	Keller	Seattle	98122	
Mary	Fleck	Seattle	98116	
Kim	Turner	Seattle	98106	
Maureen	Gerking	Burien	98168	Keep the park intact!
Donna	Brown	SeaTac	98188	
Jazz	English	Seattle	98144	
Carol	Olivier	Burien	98166	I was driven away from my beloved home and gardens in Des Moines due to horribly increased low flying aircraft that never quit. The trees that were cut down for concrete warehouses meant buffers for noise and improved air quality were destroyed. It became a living noisy prison. You cannot allow the same to happen to this precious park. And btw, shift cargo to an airport where there is train transport. The trees in the park, besides being beautiful and exchanging CO2 for oxygen for us as well as serving as homes for birds and insects, just cannot be cut down for more airport pavement and parking. We need even more parks and less parking as we move away from fossil fuels. As well, we are bombarded by noise from escalating airport jet traffic and mature trees in act as buffers from the noise onslaught.

Kevin	Gallagher	Lake Forest Park	98155	
Alyne	Fortgang	Seattle	98177	
Josh	Diamond	Seattle	98122	We need all the green space we can get. Save North SeaTac Park!!!
Jason	Pooler	Everett	98204	
Sheila	Markman	Seattle	98117	
Brett	Renville	Seattle	98103	We need MORE trees. Not less. Quit developing our natural land!
Emma	Hersh	Camano Island	98282	
Iliana	Raines	Seattle	98118	
Emma	Shorr	Seattle	98122	
Phoebe	Bryson-Cahn	Seattle	98122	
Michael	David	Seattle	98144	
Chris	Bodewell	Seattle	98118	
Michaela	Kyles	Seattle	98178	
Aaron	Kyles	Seattle	98178	
Thomas	Carpenter	Renton	98055	
Norah	Carpenter	Renton	98055	
Emma	Carpenter	Renton	98055	
Charlie	Carpenter	Renton	98055	
Tai	Kaku	Renton	98059	
Catherine	Barashkoff	Des Moines	98198	
William	Bassett	Seattle	98122	
Janette	Nuss	Normandy Park	98166	
Rob	Simpson	Seattle	98103	
Melissa	Brooks	Renton	98058	
Margaret	Gretteny	Renton	98059	
Seamus	McMullen	Tacoma	98503	
Craig	Ogden	Silverdale	98383	
Riley	Paulson	Renton	98058	
Jennifer	Paulson	Renton	98058	
Brett	Pepper	Newcastle	98056	
Ismael	Valeriano	Kent	98032	
Keith	VanDoren	Burien	98166	

Ramon	Agabo	Issaquah	98027	
David	Bacon	White Center	98146	
Garrett	Bailiff-Mitchell	University Place	98467	
AJ	Becker	Issaquah	98027	
Shane	Brown	Kent	98031	
Ty	Candler	Renton	98058	
Julie	Creswell	Burien	98146	
Jacob	Dobey	Tacoma	98403	
Rebecca	Eaton	Kenmore	98028	
L	Fakatoufifita	Tacoma	98405	
Nael	Garcia	Tacoma	98433	
Bijan	Ghambari	Renton	98056	
Brandon	Gibson	Renton	98059	
Larry	Gilmore	Marysville	98270	
Doug	Gresham	Seattle	98117	
Ric	Hall	Tacoma	98404	
Toby	Helfenstein	Renton	98058	
Maletino	Hola	Lakewood	98498	
Kennedy	Kamau	Kent	98032	
Diana	Kim	Federal Way	98023	
Nicole	Kissinger	Renton	98059	
Juanitta	Lang	North Kitsap	98346	
Jonathan	Legin	Kent	98042	
Sean	LeRoy	Renton	98058	
Peg	McClure	Auburn	98092	
Broos	McDowell	Kirkland	98034	
John	McGill	Kent	98031	
Thomas	Miller	Seattle	98107	
Jennifer	Monger	Kent	98031	
Brandon	Mooney	Bothell	98011	
Josh	Munger	North Kitsap	98436	
Mac	Murphy	Federal Way	98025	
Mike	Neary	Burien	98146	

Jordan	Oakes	Renton	98156	
Jacob	Olsen	Tacoma	98433	
Colton	Rausch	Silverdale	98383	
Nestor	Ruiz	Renton	98055	
James	Sarginson	Renton	98059	
Colsen	Sarginson	Renton	98059	
Kaylu	Sarginson	Renton	98059	
Grace	Sarginson	Renton	98059	
Jennifer	Sarginson	Renton	98059	
Joe	Schmid	Kent	98042	
Robert	Stone	Lakewood	98499	
Chris	Taylor	Kent	98031	
Thomas	Wallace	Seattle	98115	
Conner	Wells	Burien	98166	
John	Willahan	Bellingham	98225	
Lynford	Flye	Dorking, United Kingdom	RH4 1JZ	
Steven	Oster	Des Moines	98198	
George	Costakis	Edgewood	98372	
Evan	Prince	Mountlake Terrace	98043	Please save Pat Ryan Field! This field is a staple of the Rugby Washington community.
Todd	Moudy	Auburn	98092	This park has been an important part of my and my family's life for over 20 years, please protect it!
Sarah	Anderson	Auburn	98092	
Tiana	Guzman	Renton	98056	
Maximus	Hollar	Renton	98056	
Stephanie	Sanpedro	Renton	98056	
Lee	Stafford	Burien	98168	
Harlem	Beverly	Renton	98055	
Matthew Mason	Mason	Bothell	98021	
Aliyah	Recasner	Seattle	98105	
Jaiden	Reese	Seattle	98195	
Brandon	Champion	Renton	98059	

Daniela	Arias	Bellevue	98008	Pat Ryan field has been an important part of many life's throughout the years. It would be unfortunate for any of us and fellow people that appreciate this field/park. It has been an essential part of kids Life's, athletes and families around the community. It needs to stay.
Jasmine	Venzant	Seattle	98178	
Cash	Candler	Renton	98059	Getting rid of pat Ryan field would be a travesty. Not only has it been a staple rugby field for many years but it is a memorial, to build warehouses on it and destroy the field would be disgraceful
Joshua	Flores	Seattle	98102	
Dylan	Neary	Burien	98146	
Henry	Hall	Tacoma	98406	Pat Ryan field has been at the heart of the rugby community in Washington for decades. It is a safe and secure locations where hundreds of kids play rugby every year. The grass field is safer for the players than artificial fields. It is also home to many adult rugby matches providing community for young adults fresh out of high school, and generations of players. The Valley Kangaroos Rugby Football Club worked countless hours developing the land for the community. I am the son of a founding father of the club. I grew up working with my dad on the weekends on the field and our family takes great pride in Pat Ryan. It has all been in the effort of growing our community through sport.
T	Pelton	Kirkland	98034	Pat Ryan field is a huge place of community, and the surrounding area is a constant gathering ground for many. Please don't take away our community space for warehouses
Allie	Osier	Renton	98059	Pat Ryan field especially is home to many, and has made a huge impact on so many families. From growing up there to spending every weekend there for my families rugby games, to my first ever try at that same field, if it weren't for this field, I don't think mine nor anyone's rugby culture would be the same. Thanks.
Jeffrey	Smith	Cardiff uk	Cf81 9ds	Do not do this this area I have been to love the unspoilt trails and most of all seeing the kids play rugby out there.there has to be an alternative, let common sense prevail here leave this area stay unspoilt
Carly	Waterman	Burien	99166	
Kellyann	Umu	Renton	98055	I love Pat Ryan it's very important to a large community of people including me and my family and even just the people who live in the area
Shaina	Garland	Olympia	98502	Do not take away a space and staple for rugby in King County!
Emelia	Stroppa	Renton	98058	Pat Ryan field is not just some peice of grass. Pat Ryan is a place full of memories, traditions, and a place where family after family has been built, added to, and completed. By turning our field into a warehouse, you're diminishing it's importance, and taking away hundreds of kid's opportunities, as well as many adults who use that field to connect with old family and create new friendships.
Michael	Merrill	Honolulu	96830	

Dayna	Vi	Kent	98031	
Samantha	Thomas	Renton	98058	
Feta	Toso	Provo	84606	
Tucker	Andrews	Kirkland	98033	
Angelo	Del Vecchio	Enumclaw	98022	
Jack	Henefer	Mill Creek	98012	
nigel	townsend	Bothell	98021	I have been travelling down to Pat Ryan field now for as many years as the valley rugby team has had access to the area to play sports. It has moved from what was treated as superfluous land to one that the club has managed to make it more welcoming and comfortable for visitors. There has been a marked uptick in the use of the area by locals as a result of the clearing of brambles that has been completed and the fact that it is a very pleasent place to walk, sit in the sun. The land is in the midst of a very built up area and to have some local land that is available to the local residents and to sports teams alike is something that implore you to keep accessible to everyone rather than have a parking lot or yet another warehouse type structure.
Sydney	McDonald	Seattle	98118	
Tommy	Pham	Kent	98031	
Travis	Mulkey	Renton	98058	
andrea	devoto	bellevue	98004	
Britney	Short	Renton	98056	
Sabrina	Imler	Renton	98056	
Patrick	Keegan	Seattle	98107	
Liana	Wayman	Federal Way	98003	
Chris	Nedimyer	Seattle	98107	
William	Tilson	Seattle	98102	
Bryan	Vargas	St.George	84770	
Olivia	Candler	Renton	98059	
Talo	Fetuuaho	West Linn	97068	
Rico	Halsell	Tacoma	98445	

Jonathan	Brooks	Renton	98058	North SeaTac Park, including Pat Ryan Field, is an extremely valuable entity in an extremely disenfranchised area. The South King County area has very little public park space and even less access to affordable field access for organized recreation. The Valley Kangaroo Rugby Football Club has been a steward of this field and its surrounding grounds for 20 years. Losing Pat Ryan Field will be detrimental to a thriving rugby community that has few other viable means to exist. Further, the North SeaTac Park was promised to the residents of SeaTac when the Port demolished their homes for the greater public good. It is not open for discussion that the Port fulfills its promise to keep this land as a park and return it, permanently, to the community. Any development of this park would be a complete failure to the public and a permanent disgrace for the Port. Destroying an established park in such a disenfranchised, low income area, in order to develop parking lots or warehouses is against the best interests of the public, our citizens, and your constituents.
Michael	Puni	Ewa Beach, HI	96706	
heaven	samuels	orting	98360	save pat ryan 4 rugby
Jeff	Kress	Renton	98058	
Sadie	Schier	Hanover	3755	
Faith	Wolbert	Lacey	98513	Please don’t take this away from the people and especially the kids who play here. They deserve this place to play their beloved sport
Erik	Cottle	Auburn	98001	Less warehouse space more open space.
Michelle	Swetky	Issaquah	98027	
Ian	Borchert	Seattle	98115	
Katherine	Crommett	Kent	98032	Please protect this park! Washington Rugby wouldn't be the same without Pat Ryan Field!
Amy	Drackert	Kirkland	98034	
Amanda	Gibson	Renton	98059	Save our open spaces!
Elisabeth	Ford	Tacoma	98406	
Austin	Liddell	Renton	98059	This park was a significant part of my childhood. I grew up playing rugby at this field and made many lasting friendships. My wish is that my kids will one day play for the same team on that field.
Spencer	Terrien	Issaquah	98027	Recreational sports > state profit.
Colton	Overbeck	Bellingham	98229	
Brooke	Baker	Seattle	98133	
Jermiah	Russell	Seattle	98122	
Parker	Kimmerly	Renton	98059	
Kellie	Sadettanh	Spokane	99223	

Unpublished name		Seattle	98109	Hi, I'm a Tongan American who played rugby throughout high school. When I moved back to Washington my senior year, after spending the previous years in Hawaii, it was hard to make new friends and create connections with the Polynesian community here. But playing rugby helped me find my community. This park isn't just a park. It is a safe place for the Polynesian community to come together and celebrate our love for rugby. Many of us are immigrants or first generations, and this park is like a piece of home. Please don't take this away from us.
Michele	Gruenwald	Lopez Island	98261	This is a beautiful field that gives athletes a wonderful place to practice, and play. And those of us who love to watch athletes as well as a place to walk in the midst of the city we need places like this to keep our sanity in this crazy world please please protect it.
Nelly	Riley	Burien	98168	Save this beautiful green area that we so much enjoy, not just seatac neighbors but all neighbors surrounding the park
Orianna	Sanele	Tacoma	98405	
Robert	Holden	Kirkland	98034	Save Valley Rugby and all its affiliates including youth and adult fundraising and community activities for the SeaTac area. Any housing developments or businesses would not be viable for this location due to its proximity to the airport's flight path anyway. Leave it alone to preserve the benefits Pat Ryan Field provides for the area.
Alex	Cannon	Seattle	98195	Pat Ryan field is extremely important to the rugby community. It would be such a huge loss if it was taken over.
Heidi	Strasser	Renton	98059	
Marley	Salevao	Federal Way	98023	
Faamanuia	Faalavaau-Brown	SeaTac	98168	
Melonie	Couch	Lake Stevens	98258	Rugby is a very important part of my life.
Unpublished name		Sumner	98390	My kids have grown up playing rugby at Pat Ryan Field. It give 100's of kids and adults a place to play rugby. It's a gathering place for families and even after the match we go to the park across the street to enjoy bbq and spend time as a family. Why do we keep killing our earth and ripping life from it? The trees provide clean air, protection, shade and home for animals. There has to be another solution. I also work for Northwest Kidney Center and our patients get to enjoy this location, it is relaxing while being on dialysis 4hrs every other day. It brings peace and healing. We need to do better!
Joel	Brown	Burien	98148	
Nathan	Kimmel	Portland	97003	
Joseph	Boyd	Salem or	97302	The rugby field is an amazing place. I have played there many times and would hate to see it be taken away from the community.
Taane	Staladi	Renton	98059	I have been playing on this field since I was 13 years old! A whole rugby community relies on this field! The effect on us would be detrimental!
Eli	Yarnold	Auburn	98001	
Megan	Joens	Bend	97701	

Kalesi	Umu	Marysville	98270	As a liberty (rugby club) alumni, we love pat ryan and have been using that field for years, it's very special to us, we would love to spend many more years using it.
Maryanne	Vakamoce	Renton	98055	
Joe	Tuisee	Beaverton	97005	
Dazzlynn	Lafoga	SeaTac	98188	
Unpublished name		Federal Way	98023	There's so much memory on that field. That field represents a community and family of individuals from k-12 grade and up created.
Ben	Granger	Marysville	98270	
Nicole	Candler	Renton	98059	
Lillian	Loranger	Seattle	98118	
Jake	Bailey	Seattle	98118	
Tysen	Gray	Portland	97206	
Erin	Rowden	Yakima	98902	
Jared	Hubbell	Seattle	98119	
Noah	Heye	Olympia	9850-	
Jade	Hill	Portland	97209	This park means so much to a broader community than you think! Please keep it safe.
Joseph	Lincoln	Seattle	98107	
Nelson	Cooper	New York	10009	
William	Joslyn	Federal Way	98003	
Isaiah	Loucks	Seattle	98109	
Tiffani	Candler	Renton	98058	
Mark	Thompson II	Lakewood	98499	
Jamie	Fualaau	Puyallup	98373	
Sera	Umu	Marysville	98270	
Jon	Swezey	Mammoth Spring	72554	
Devereaux	Ferris	Burien	98168	
Austin	Tijerina	Portland	97232	
Zachary	Webb	Portland	97206	I am a member of the PNW rugby community and love coming to play at this field. It's one of the better facilities in the area and to lose it to airport development would be a disservice to the community that cherishes and cares for the space.
Peter	Bryant	Portland	97203	This field builds community in Seattle and the wider Pacific Northwest. Replacing it would do irreparable damage to the lives of men young men who would be robbed of an opportunity to socialize, exercise and build life long bonds.
Justin	Howe	Portland	97218	

Zaeem	Awan	Vancouver	98662	This space allows for hundreds of all ages to play rugby all year long. Without it many would loose the opportunity to play a sport that builds character and provide a safe place to grow and develop.
Enrique	Lopez	Portland	97236	
Ben	McDowell	Portland	97217	
Josh	Culmer	Portland	97232	
Josh	Tabak	Portland	97211	
Joshua	Sheets	Vancouver	98661	Please dont take away pat ryan field. Its big in the rugby community and a home field for on of our teams.
Jacob	Franchetti	Hillsboro	97006	Rugby is already a struggling sport in the US, Don't make it harder by taking away a field we can play on and a teM calls HOME!
Hillary	Gonzalez-Delgado	SeaTac	98198	This park has been around the entirety of my life, I have ran middle and high school races at North SeaTac park. It is one of few green spaces we have access to, it would be incredibly unjust to take what little we have left. The port’s greed should not extend to a community resource that builds connection and improves our society as a whole. We need this park more than the port needs warehouse.
Alex	MacDonald	San Francisco	94123	
Tonicia	Poe	Renton	98057	
Shannon	Holliday	Mammoth spring	72554	
Andrew	La Husen	Beaverton	97005	
Kayla	Clark	Olympia	98503	
Penina	Tuilaepa	Federal Way	98003	Taking away Pat Ryan field will ruin the culture of Rugby within our state. I grew up playing on Pat Ryan to now coaching on that same field. It’s a staple in the rugby community and means much more than just a patch of grass. It’s home to many and a place for us to gather! Taking it away will mean teams will have to pay for fields elsewhere in this crowded state and more kids on the streets instead of on the pitch
Brandon	Romero	Burien	98168	I've been coming to this park since I was 10 years old, I'm 28 years old now and I still bring my dog here to walk the trails almost everyday. Even with the airplane noise this park can be peaceful and useful for so many things. I've run laps and played soccer on the rugby field, I've ridden my bike through the mountain trails, I've done loops around the park for hiking training. I've seen so much amazing wildlife here too, including multiple owls! It would be a shame for this park and trees to be destroyed for some auxiliary airport thing where the public will no longer be able to enjoy the green space.
Sean	Magraw	Sandy	97055	
Joy	F	Seatac	98188	
Liam	Noone	Seattle	98103	
Michael	Cruz	Portland, OR	97217	

christina	osier	Gig Harbor	98329	
Papu	Matau	Vancouver	98663	
Martinique	Quick	Seattle	98126	There are very few fields available for rugby use, please save this one.
Lauren	Barber	Seattle	98115	
Chay	Fuimaono	Covington	98042	
Claire	Schachtely	Portland	97232	
Josephine	Fesili	Auburn	98001	
Marques	Fualaau	Kent	98042	
Rovena	Samoa	Puyallup	98371	
Thomas	Packebush	Philomath	97370	
Ellena	Takai	Seattle	98168	
David	Boedeker	Port Orchard	98366	
Kale	Daniels	Des Moines	98198	
Alex	Fisken	Glasgow	G62 7HA	
Kimoura	Blankenship-Flinn	Seattle k.l.blankenshipflinn2@gmail.com	98178	
Orion	Lehnert De Smet	Seattle	98125	
Todd	Stratton	Tukwila	98168	
Daniel	Lopez	Lynden	98264	
Taane	Staladi	Renton	98059	
CALLUM	Young	Lakewood	98498	
Jennifer	Vail	Seattle	98146	
Jake	Spiller	Mercer Island	98040	Please save Pat Ryan field for the rugby community.
Chance	Keyes	Post Falls	83854	Removing Pat Ryan field will be a huge blow to local youth boys and girls as well as men and women rugby players to all of the Northwest. Amazing humans and great feats have been created and accomplished on this field. To develop the park would do nothing but hurt the surrounsing community. People from all over the area come and walk or play football and soccer on pat ryan. Please reconsider developing so we can ensure that current and future generations can thrive through the sport of rugby to become great men and women just like those who have come through Pay Ryan before them.

John	Cullen	Snoqualmie	98065	Let’s keep this community asset green and available for recreational activities.
Megan	Ward	Denver	80203	As a PNW native and member of the rugby community, this park is incredibly meaningful and a beautiful natural space for the community. Green spaces are essential to the biophilia of humans and this one is no different. We deplore you to keep this park and consider the impact of expanding an already lackluster and deteriorating SeaTac airport.
Jack	Cannon	Seattle	98105	
Ty	Tadano	Bainbridge Island	98110	
Jonny	Chambers	Redmond	98053	Rugby needs a space.
Thomas	Ball	Bremerton	98337	Pat Ryan Field is critical to a large community of Rugby Players in the PNW. It is one of the only dedicated rugby facilities and draws players from across the region to visit Seatac. It's long-term future needs to be safeguarded as part of the local economy.
Patricia	Fronczak	Mukilteo	98275	
Karina	Bridgman	Seattle	98112	
Jeff	Ives	Renton	98057	Please do not absorb this great pitch it is very important to the development of our youth it gi e them a positive activity and this club is a great place for our your to be a part of
Jose	Romero	Sammamish	98075	
Jeff	Blakley	Port Ludlow	98365	Hello. I am a friend of Liberty Rugby, and am requesting that North SeaTac Park and Pat Ryan Field be preserved. Thank you.
Unpublished name		Seattle	98168	We need to save the trees, the community, all the people who use the field, the animals that has the field and global warming. We use this field almost daily and this cannot happen.
Unpublished name		Covina	91723	This park has been a bastion of brotherhood and friendship. Blood and tears have been spilled on this pitch and it is unacceptable that commercial development is considered here
Unpublished name		Puyallup	98375	Pat Ryan Field and the surrounding North SeaTac Park is vital to the entire community and area. We still need green space and trees to make a thriving community. We don't need more asphalt and warehouses. We need the shade, the grass and recreational space. People complain that kids don't do anything but play video games and get into trouble. Leave them a space to play outside! Leave a space for organized recreation and activities! This is also the place where our rugby community meets and grows. In a few years we will be hosting Rugby World Cup. Make a commitment NOW to the rugby community, the larger community of SeaTac and Burien, the environment and all the children who use and need this space.
Unpublished name		Seattle	98058	Please, these parks do so much good
Unpublished name		Burien	98168	Plzzz save Pat Ryan! Its place where ppl who love rugby come!

Unpublished name		Bonney Lake	98391	We need Pat Ryan field. It is helping the development of our youth and future communities. Rugby teaches the quality morals and ethics needed for a healthy community.
Unpublished name		Puyallup	98375	Grew up playing rugby on that field, lots of memories for my family and a big community hub.
Unpublished name		Tacoma	98405	Stop uprising communities for capital gain.
Unpublished name		Issaquah	98027	Pat Ryan field is a much loved and needed dedicated Rugby field for our youth! The sport embraces family, respect and community!!
Unpublished name		Federal Way	98003	Rugby NEEDS the green space! SAVE PAT RYAN
Unpublished name		Federal Way	98003	Save the field!
Neil	Datt	Seattle	98121	
Christian	Quinn	Seattle	98155	
Nicole	Mathis	Olympia	98513	Please save North SeaTac Park Community Forest! I am from Olympia but enjoy the park when we are in the area. The rugby field is incredibly important as well - we've spent many a Saturday there supporting not only our own child and his team, but ALL of the youth that have the honor of playing on that field. It's incredibly important to so, so many families. Thank you
Alicia	Abraham	Lake Oswego	97035	
Emily	Dodd	Renton	98059	Please do not take this park away from the community. Pat Ryan Field resides in this park, which is where several community rugby teams play. This field means a lot to the rugby community and we will be heartbroken if it goes.
Kimberly	Lui	Auburn	98092	
MJ	McNeill	Renton	98057	
Thomas	Kloetzli	Redmond	98053	
Deanna	Schultz	Buckley	98321	
Eric	Fleming	Bothell	98021	
Andrew	Kiernan	Seattle	98107	
Jaren	Rhea	Vancoucer	98662	Rugby plays a large role in giving youth and adults a safe outlet to express themselves and continue playing in a competitive sport. Through rugby we have taught youth and adults respect, courage, how to overcome adversity, and to freely express themselves in a safe and caring environment. It is becoming more challenging to find space to play this incredible sport and Pat Ryan field is used by a magnitude of youth and adult teams in the greater Seattle area. Without it who knows where these teams go and will the rich history of rugby in the greater seattle area decline or disappear?

Cori	Roed	Seattle	98146	This open space was granted to the community in compensation for the many negatives that come from the growth of the airport. Airplanes and port activities are HUGE greenhouse gas emitters and the trees in this open space are needed to absorb all that c02. The idea that it's OK to renig on that promise and pave over enormous swaths of open space is despicable. If you need more parking for Port activities, put it underground. Leave this park alone. Cori Roed
Angela	Veetutu	Bellevue	98006	
Paula	Morrell	Bremerton	98311	
Shannon	Whitemarsh	Spanaway	98387	
Randy	Anderson	Stanwood	98292	
Jessica	Shabazz	DesMoines	98148	
Amber	Zieske	Olympia	98501	I travel from Olympia at least twice a year to visit this park. It is essential to keep our green spaces.
Elizabeth	Ritz	Oak Harbor	98277	My daughter's rugby team considers this space their home field. There is limited field space in the area and our girls depend on this field space. Please don't take it away!
Richard	Gogo	Tukwila	98168	I grew up playing Rugby here and kept me off the streets of Seattle. Taking this field away puts 100’s of kids at statistical disadvantage to over come adversities. Rugby saved my life. Taught me discipline and what it means to be a man. This is more than just a field it the home of the LIBERTY PATRIOTS RUGBY CLUB.
Joshua	Garcia	Kent wa	98031	
Chris	Rodde	Seattle	98103	
Michael	Faust	Tukwila	98188	
Mary	Osier	Renton	98059	
Walter	L	Vancouver	98682	
Melissa	Falk	Kent	98030	This park has thee only Rugby Pitch (field) in the area. It is used by a large Rugby community full of kids who are thriving through this sport. Please do not take away the only place we have to play and host games against other clubs. This is our home!
Laura	Geringer	Bellingham	98225	
Laurent	Cauchi	Issaquah	98027	We need this space, 1000s of kids participate life changing opportunities for growth through sports and community.
Matt	Pacheco	Tacoma	98407	Pat Ryan has been a staple of rugby in the NW and the development of the game and great players.
eren	eremenko	everett	98208	
Norman	Arnett	Bothell	98011	
Brian	Thorp	Vancouver, WA	98663	This field is an important place for local rugby and has been for a very long time. Without it it will be much harder for the teams that use it to continue playing.

Sean	Twohey	Seattle	98106	Pat Ryan Field within the park is a vital hub for the youth an adult rugby community in the area. Tbis is a diverse multiracial a d inclusive community. Many lower income youths from the SeaTac, Tukwila, Renton and Burien areas. use tbis facility and the surrounding park as part of subsidized and free sporting programs provided by Liberty Rugby Club, a registered nonprofit youth sports organization.
Chester	Smith	Renton	98059	
Natalie	Gronzo	Olympia	98503	I grew up playing on this field and still continue to do so as an adult. I know many others with this experience and many wonderful memories in this park. It would be disappointing to see that come to an end.
Gabe	Koenig	Brush praire	98606	Pat Ryan field is a great hub for the community to gather and enjoy being together. My rugby team had played there many times 1 because we love it and 2 because there no other rugby fields around. Save pat Ryan field!!
Ethan	Wieringa	Seattle	98027	
Monica	Rosellini	Renton	98059	
Jone	Naisoro	Renton	98058	
Joe	Zagunis	Bend	97701	
Boris	Kogan	Camas	98607	The rugby field of very important to the community! Very few dedicated parks remain.
Steven	Whitlock	Issaquah	98027	Our future depends on the community keeping this park! Our youth are having less options for healthy activities! Having the chance to play rugby installs teamwork, commitment, & dedication that is vital to becoming a responsible adult within the community! You take this park away, you are also taking away the future for generations! Life is more important than greed & money! It makes me sick to see nobody cares about the kids or community any more! Government and corporations are taking everything away that's beneficial to our survival! Stop taking & start giving back! You work for us! Rugby 4 ever!
Jeremy	Nash	Seattle	98109	
Tyson	Tepes	Lake wood	98498	This field and all the trees are not only a great spot to hold events. But it’s also holds history. The rugby teams that come and play at pat Ryan leave thinking this park is the BEST! Please think twice before you destroy this beautiful land
Jedediah	Berman	Lacey	98513	
Lyle	Smith	Renton	98059	Our family’s rugby club, Liberty, has our home field at Pat Ryan. It’s an important part of our community.
Katie	Knutzen	Issaquah	98027	
Elspeth	Parrish	Olympia	98502	Please preserve Pat Ryan Field, an important asset for PNW's rugby community!
Carrick	Macleod	Tenino	98589	This was the first field I played rugby on and it means a lot to the rugby community! Please dont take it away from all the kids that have yet to have a chance to make their first memories on this pitch!
Brianne	Thomas	Olympia	98502	

Jamie	Barnwell	Lacey	98513	
Alma	Reantaso	Burien	98168	
Diana	Brooks	Ravensdale	98051	
Leah	Semeraro	Seattle	98107	Please help us keep this field! It has been an integral part of the rugby community and has helped give so many of us a home! Pat Ryan field is one of a kind, please help keep our community alive!
Aaron	Erickson	Kent	98042	
Sam	McLeod	Wellington, New Zealand	6012	
Jacob	House	Silvercreek	98585	
Brooke	Newman	Renton	98059	
Chris	Stone	Kirkland	98033	
Angela	Holt	Bellevue	98005	My son played on this field it was a part of our heart and soul!!
Faye	McMoore-Ainuu	Olympia	98501	
Aaron	Lee	Covington	98042	
Travis	Spuhler	Tacoma	98444	Removing facilities that have been well used, lovingly maintained, and actively benefitted hundreds, if not thousands of youths and adults would be hugely detrimental to everyone. If any port officials want to see the positive benefits of any of the activities at locations such as Pat Ryan field, please, reach out to the local rugby clubs.
Kathleen	McHugh	Kirkland	98034	
Scott	Wright	Renton	98058	
Mason	Glover	Des Moines	98031	Your profits are not as important as the mental health and well being of the individuals that utilize these facilities. With all disrespect F*ck off
Matt	Schmidt	Bend	97702	
Sarah	Webber	Renton	98059	These green spaces need to be kept and maintained!
Carrie	Daggett	Everett	98204	Preserving our green spaces and recreation space is essential to the health of all of our community!
adella	voytovich	renton	98059	
Mark	Zetterberg	Auburn	98001	This park is the home of one of the few dedicated rugby pitches in Seattle. It hosts high school, club and championship games and competitions, and needs to be preserved as it is. Add another runway/airport somewhere else!
Lo	Lo	Renton	98056	
Kylie	Candler	Renton	98958	
Priscilla	Sahagun	Renton	98059	
El-Desicca	Lefiti	Kent	98032	
Brian	Harvey	Tacoma	98422	

Staci	Reim	Renton	98059	Pat Ryan field is HOME to 200+ Liberty Rugby players who come from all walks of life. They are a family and the Liberty culture is 2nd to none. I am proud to be a part of this rugby community who also supports their local communities, especially underprivileged kids. Don't take away this important field!
Emily	Moran	Bend	97703	
Po	Leapai	Burien	98168	
Mylissa	Twohey	Buckley	98321	We have used this field for Rugby for more than 10 years, it is a staple place we visit January through July. Please do not change the spaces use.
micheal	angelo	sammamish	98074	
Emily	Chard	Seattle	98116	
Jacqueline	Morris	Bellevue	98096	
Romeo	Naisoro	Everett	98201	Please don’t get rid of the field
John	Ray	Yakima	98901	Thank you for doing this! I’m doing it on behalf of saving Pat Ryan field, where rugby is a flourishing sport in the area! Losing that field would displace thousands of rugby players, and I’ve played here many times!
Eve	De Cremiers	Issaquah	98027	
Julia	Bates	University Place	98467	
Agnes	Leapai	Burien	98168	
Teresa	Harris	Puyallup	98374	
Kendra	Senecal	Spanaway	98373	
Stoney	Bair	Renton	98057	
Jesse	Faimalo	Burien	98148	
Mosese	Lalasava	Edmonds	98026	
Devin	Toth	Portland	97209	SAVE the rugby PITCH!
Sasha	Van Muiswinkel	Lacey	98503	
Winston	Rockwell	Chehalis	98532	
Melissa	Luper	Olympia	98516	
Melissa	Luper	Olympia	98516	
Olive	Kilifi	Tukwilla	98168	
Red	Love	Renton	98058	Pat Ryan is home to many and it is understandable to overlook a simple field but it’s much more than that, many family and friendships have been established on this pitch and it just stand for future rugby generations to continue our tradition.
Taylor	Heimbigner	Renton	98059	
Jerold	Pickard	Issaquah	98027	Open spaces are far more important for our kids and communities than parking lots and development. Protect Pat Ryan Field and North SeaTac park!
Jenell	Staladi	Renton	98059	

Brooke	Ury	Newcastle	98059	
David	Jones	Renton	98057	
Semisi	Vete	Portland	97209	
Alfred	Tafuna	University PLACE	98467	
Unpublished name		Snoqualmie	98065	This field and the sport of rugby has made a MAJOR impact on my son's life. Rugby is an inclusive sport. It got him through a lot of ups and downs I would be heartbroken if the younger generations aren't able to take part in this!
Unpublished name		Issaquah	98027	Pat Ryan Rugby Field is iconic and important to the community.
Unpublished name		Tukwila	98188	We need rugby in this area! Youth rugby needs a space to practice their game. Don’t take this to develop an airport, keep it green and open!!!
Unpublished name		Burien	98146	Please, please, PLEASE don't take away the pitch! Youth rugby is THE BEST!
Unpublished name		Everett	98203	I played many rugby matches on this field while I was in high school. Though I don't play anymore, I know the field is still a very important part of the rugby community as it's one of the very few dedicated rugby pitches in Washington State. Please leave Pat Ryan Field alone. It may not look like much, but it means a lot to the rugby community young and old.
Megan	Adams	West Linn	97068	
Desi	Arnaiz	Renton	98059	
Valerie	Bank	Seattle	98118	
Micah	Bartlett	Bellingham	98226	Thank you for maintaining this invaluable green space for recreation.
Rachel	Bays	Oregon City	97045	My husband played on this rugby field throughout high school. We now have a son and we cannot wait to see him grow up playing rugby and hopefully play on some of the same fields his daddy played on.
Chenoa	Bercier	Olympia	98512	
Walker	Breitner	Vancouver	98662	Save Pat Ryan Field
Kris	Carroll	Fort Wayne	46818	
Greta	Chenu	Seattle	98195	
Kira	Comfort	Bellingham	98226	
Julie	Conner	Benbrook	76126	
Peter	Cost	Tacoma	98402	
Christina	Davis	Olympia	98502	
Straw	Berry	Seattle	98101	
Russell	Davis	Kent	98031	
Gary	DeGolier	Tukwila	98188	
Sara	Dumlao	Maple Valley	98038	Yes

Karim	El Naggar	Issaquah	98027	
Noemi	Flores	Renton	98055	
Carmen	Fualaau	Kent	98042	Keep Pat Ryan Field!! This field is very important to the rugby clubs that use it 30 times a year or 1 time a year. Rugby is more than a game, it is an opportunity for kids to get athletic scholarships and go play as a student athlete in college. The would never be able to afford or attend college in any other manner. It also brings commitment and community to many Pacific Islanders and surrounding cultures. Pat Ryan Field is essential in keeping this sport in the Pacific NW from youth rugby to adult rugby.
Donald	Gallon	Tacoma	98404	
Traci	Garcia	Renton	98058	
Thomas	Glass	Federal way	98003	
Owen	Gonder	Seattle	98108	
Kellen	Gordon	Auburn	98002	
Cannon	Hansen	Poulsbo	98370	We love coming from out of town to pat Ryan to play rugby, it’s the only pitch around that is a dedicated pitch for rugby play. There are a lot of clubs in the surrounding area that enjoy playing here.
Megan	Hays	Kirkland	98034	Support youth rugby and protect their feild
Kylie	Henderson	Des Moines	98198	This is the only rugby field within 40 minutes of us. Don’t let it become a parking lot. So many great things for families to do at all the various fields. We go for soccer, see people playing cricket, riding bikes, and enjoying the outdoors.
Priscilla	Hernandez	Bremerton	98310	
Tami	Hill	Edmonds	98026	
Stephanie	Hook	Tacoma	98422	We need more green spaces, less concrete
Matt	Hudson	Richland	99352	
Gabi	Illi	Everett	98201	
Trinity	Jinks	Tacoma	98467	
Katie	Kato	Tukwila	98188	
Holly	Knowles	Gold Bar	98251	
Erica	Legaspi	Tumwater	98512	
Michael	Ling	Shreveport	71106	
Anna	Ludwig	Seattle	98107	
Carly	MacKinnon	Seattle	98115	This is one of the ONLY rugby-specific fields, only grass one, in the greater Seattle area that is used by youth all the way to adults within the rugby community. This field should be receiving support and upgrades, not threatened. Our communities need more trees and parks, not buildings and warehouses. Get the priorities reset, PLEASE!
Winnie	Maile	Seattle	98168	Please leave it alone we want liberty to have their field

Matthew	Manley	Portland	97220	
Anayi	Merrill	Portland	97217	Rugby needs to be recognized as a sport and provided designated fields. Do not limit the options children and young adults have for some airport renovation. Prioritize rugby!!!!
Joseph	Meyer	Lufkin	75904	
Colin	Miller	Dupont	98327	Destroying green space in the aftermath of the pandemic shutdown exacerbates the health problems (weight gain, lack of exercise) that we will be paying the price for over the next few decades.
Elizabeth	Moegu	Tacoma	98404	
CJ	Mullins	Bellingham	98226	
terry	mutter	normandy park	98166	The Port says it wants to be the most sustainable airport in the country - show it beyond platitudes and window dressing. Being sustainable doesn't mean being "less bad".
Jone	Naisoro	Renton	98058	Pat Ryan field means a lot to our community from youth to adults. We hope that it will be protected so future youth and members of our community may enjoy it.
Michael	Nguyen	Renton	98055	My wife and I have enjoyed going to watch local rugby out at Pat Ryan Field, and it would be a pity to see this option disappear for this wonderful sport.
Dawn	Pacheco	Renton	98056	
Sage	Pavey	Brisbane, Australia	4034	
Taylor	Pearson	Seattle	98112	This field provides space for multiple different rugby teams of all ages. This is the only official field space in the area and promotes family sports, sportsmanship, having the security of a home field, and more memories than anyone can count. This is a very special space that needs to be kept in its natural state!
Mindy	Pen	Federal Way	98003	
Anne	Peterson	Seattle	98144	Pat Ryan is such an important field for the rugby community in and around Seattle. With limited fields available around Seattle it is extra important that we maintain this rugby specific field!
Robert	Schierholz	Renton	98059	
Cassandra	Scroggs	Burien	98148	
Victor	Sisk	Kirkland	98034	We need all the green space to help against global warming and sports Fields for our youths.
katie	sorenson	renton	98059	
Raykyle	Taisague	Tacoma	98446	Save Pat Ryan field for the rugby community pls.
brian	tax	bothell	98021	
Shaina	Thompson	Hoodsport	98548	
Zander	Tkel	Tacoma	98409	

Emily	Vyhnanek	Seattle	98144	
Michael	Marks	Seattle	98116	Pat Ryan field is an important part of the rugby community in this area. Furthermore, it is the only rugby specific field south of the city. On a personal note, it was one of the few safe places for me to visit during the pandemic that gave me a sense of hope that we would get out of this traumatic time; walking along the pitch, even as the rugby season was canceled due to Covid, this rugby oasis in the Puget Sound provided solace for me during that stressful time.
Unpublished name		Seattle	98118	Pat Ryan Field has saved a lot of young lives from the streets. It gave the youth a chance to have fun and build a family through the game of rugby we all love. - Former Athlete at Pat Ryan Field.
Unpublished name		Seattle	98101	Protect the park and rugby field!
Theresa	Stone	Kirkland	98033	
Christopher	Reed	Denver	80246	The Park and activity fields are critical to the enjoyment and development of communities and individuals through sport. Please keep this in mind for the greater community good.
Colleen	Jensen	Renton	98059	
Ryan	Glendenning	Seattle	98125	Pat Ryan Field is a vital piece of the community not just in the greater Seattle area, but the entirety of the state. It is the central meeting point for the youth Rugby WA organization and provides the chance for student athletes to compete on a state and national level through the Loggers All Stars teams that others would not have. I believe that essentially destroying Pat Ryan Field would be a travesty to the aspiring student athletes and families across the state.
Lilian	Overbeck	Winthrop	98862	I grew up watching my brother and my friends entire family play on that field. Now my friends play there, and I can’t imagine another green space, especially one so full of memories, being lost to another industrial expanding project. Let’s keep our community healthy by saving the park, we promise sea tac airport will run just fine without it.
Tristan	Ingold	Seattle	98119	
Unpublished name		Kenmore	98028	The rugby fields provide one of the few playing spaces for youth training and development in the greater Seattle area.
Unpublished name		Seattle	98109	This park means so much to so many folks. It’s also only 1 of 2 accessible rugby fields for folks in the Seattle area.
Ciara	Cooper	Burien	98148	

Sophie	Demandolx	Bellevue	98004	Pat Ryan rugby field is an extremely important rugby field in the Seattle area since it is the only rugby field in the area. Without this field, rugby as a sport is deeply threatened in the Seattle area since all local rugby clubs are using this pitch. Please find a solution to save Pat Ryan or deliver a permanent awesome and easily accessible rugby pitch for all nearby to support the rugby community and allow the sport to thrive. There are many non-profit rugby clubs in the King county area - from Seatac to Woodinville - that would be devastated if their unique rugby pitch would disappear. Thank you very much for your attention.
Rena	Echols	Monroe	98272	
Susan	Ladan	SeaTac	98168	
Dorah	Leaupepe	Kent	98032	Please do not take Pat Ryan field away! I played rugby there my high school years along with many of my Islander friends and as a Pacific Islander, we often get stereo typed. Falling into “Gangs”, getting told we’ll never be more than a diploma if we were lucky enough to even graduate. BUT having the opportunity to have that safe space was EVERYTHING! Pat Ryan field was what we looked forward to every Saturday. I ask that you leave it how it is, for generations of not only Pacific Islanders but those who have been a fallen victim of stereotypes. Leave that to be their safe space.
HaeSue	Park	Kirkland	98033	
Catherine Fifita	Vea	Bonney lake	98391	Pat Ryan field is super important to me as a past Lady Liberty rugby player, I’ve made memories with my team, shed blood sweat and tears on that field I want to share that legacy with my children and see them play on that same field
Lolina	Lautoa	Puyallup	98058	
Emmy	Mwangiri	Federal Way	98023	
Samantha kyle	Atienza	Federal way	98003	
Brian	Haun	Gig Harbor	98335	
Magena	Kuhnhenn	Seatac	98188	
Natalia	Alice	Renton	98057	
Georgia	Brown	Miramar	33027	
Josh	Clegg	Renton	98056	SAVE PAT RYAN MEMORIAL FIELD!
richard	hall	tacoma	98404	Save PAT RYAN MEMORIAL FIELD
Lisa	Hewitt	Renton	98059	
Emma	Leet	Renton	98059	
Kayla	Miele	Massachusetts	(0) 6119	
Melissa	Mora	San Diego	92106	
Devin	Patrick	Lake Tapps	98391	Please stop displacing people.. Our field impacts 10, 000 people across the metro area and has changed them lives of countless people.

Jennifer	Williams	Puyallup		
Marek	Wright	Renton	98058	Save Pat Ryan Field
Ryan	Youngman	Seattle	98102	Community over corporations please!
Kristi	Johnson	Ferndale	98248	
Brian	Huntziker	Seattle	98118	I've enjoyed many rugby games and Pat Ryan field. Please don't tear it down and make the world a worse place, there is enough of that going already.
Oliver	Otterbeck	Bremerton	98310	Valley Rugby has been great stewards of their portion of the park. Also we need more green space for the community to enjoy.
Makalita	Malietufa	Seatac	98188	Please save this field for our youth!
Tuatau	Faalevao	Tacoma	98404	
Andrue	Hart	Austin tx	78758	When I was an 18 year old living without his parents. This field and The Valley Rugby team, helped me become the person I am today, and out of trouble.
Lauren	Dodd	Renton	98059	My home rugby field!!!
Liza	VanCamp	Renton	98059	
Jeremiah	Sio	Orting	98360	Pat Ryan Field has a long history of rugby. We will not give up the pitch as blood, sweat and tears were shed on this field.
Rachel	Crichton	Seattle	98146	
Helen	Hunt	Auburn	98002	
Rebecca	Gorrell	Port Orchard	98366	
Christine	Neuffer	Tukwila	98168	
Andrew	Detiveaux	Knoxville	37920	
Ashley	Whipple	Seattle	98112	
Shane	Petersen	Renton	98055	
Anna	Baena	Beaverton	97008	
Andre	Fan	renton	98059	
Anthony	Petruzzo	Renton	98059	w liberty rugby team
Erin	Stroppa	Renton	98058	Please don’t destroy our pitch. It is the home field for Liberty Rugby Club and is essential to their youth sports program. Please don’t take this from our kids.
MATHIS	DEMANDOLX	Bellevue	98007	
Mikayla	Jaeger	Issaquah	98027	
Gabrielle	Simmons	Carnation	98014	It has the one true rugby field in the whole Seattle area and is a very integral part of the Seattle rugby community.
Brooke	Jackson	Tacoma	98444	
Emily	Pitman	Tacoma	98408	
Brittany	Lobe	Kent	98042	

Geoffrey	Freeman	Kirkland	98033	This park is home to the Liberty Rugby and Valley Rugby Football Clubs. The rugby pitch there is a gathering place for teams across the Pacific Northwest, and the loss of that pitch would be an enormous blow to the rugby community in the entire region. The rugby community promotes diversity, equity and inclusion in an unmatched way, so this would also be a huge blow to those efforts. PLEASE PROTECT THIS VALUABLE RESOURCE.
Andrew	Smith	Kenmore	98028	Rugby > airport
Elizabeth	Kercher	Spokane	99223	Please save this field or create another space for youth rugby!!
Barbara	Connor	Renton	98059	Please!
Sarah	Sanford	Kirkland	98033	
Kenneth	Hynes	Easton	18042	
Crystal	Parker	Vancouver	98671	
William	Meyer	Edgewood	98372	
Kevin	Swiryn	Issaquah	98027	
Matt	Welton	Walnut Creek	94595	
Duncan	Moore	Redmond	98052	
Bode	Rothenberger	Bonney lake	98391	
Janet	Hogan	Federal Way	98003	
Britton	Harper	Andover	67002	Parks and green space are a necessity for public life and wellbeing.
Matt	Bowman	Cold Lake	90210	
Sarah	Palladino	Fort Worth	76133	
Ethan	Scott	Memphis	38107	
Raymond	Toso	Federal way	98003	
Elizabeth	Beauchamp	Missoula	59802	
Kasha	Roseta	Lakewood	98498	
Sarah	Leonard	Portland, Oregon	97221	
Chris	Zagorski	Rocky Hill	6067	
Ryan	Clapp	Seattle	98107	
Amelia	Edwards	Covington	98042	
Nicole	Steele	Spokane	99216	
William	Leonard	Portland	97220	
Marc	Staiger	Seattle	98115	Please consider Pat Ryan field as a permanent home for Valley Rugby and the local Rugby community.
Justin	Snyder	Lander	82520	

Unpublished name		Seattle	98112	We need this park!! Hundreds of children play there each week! We do not need more parking or pavement!!! Our kids need to learn to communicate and play together and to exercise good sportsmanship. Please, please protect our children's development!!! And so many people go to that park to relax and rejuvenate from the stresses of life. People rely on that park for their mental health. This is a heavily, heavily used park!
Amanda	Nurrenbern	Reno	89506	Fields are sacred for people of all ages. Kids to adults. I've lived in places without enough fields and it's terrible on the community, on each person's health, and just overall an uglier city. Keep the field. Don't lose what you have!
Daniel	EB	Incirlik	9824	
Soni	Umu	Marysville	98270	
Sammy	Vulano	Auburn	98002	
Jene	Mitchell	Chicago	60644	Green spaces are integral to the quality of life of humans and all living creatures. Airports or not. Stop destroying green space for ministry gain. We still have to be able to breathe on 20 years.
Deshon	Bell	Shelton	98546	
Katie	Arrowood	San Antonio	78233	
Jamie	Frech	Ann Arbor	48108	
Candace	Balderas	Arlington	76014	
Mary	Williams-Barber	Chicago	60614	
Rachel	Dayton	Levittown	19054	With you!
Brock	Rudney	Washington DC	20024	Save the Seattle Rugby community!
Caitlin	Jenkins	Athol	83801	
Lauren	Elliott	San antonio	78228	
Levi	Hartwig	Seattle	98133	This is a major part of our community. Please do not take this away.
Vanessa	Ryan	Bellingham	98225	
Jordan	Brown	Mount Vernon	98273	This space is extremely important to the rugby community. Everyone deserves a green space and there are no others in the area!
Morgan	Dayton	Seattle	98122	
Gretchen	Meister	Laramie	82070	
Keegan	Perkins	Atlanta	30082	People need a place to exist, stop govt. Encroachment
Tessa	Lutterman	Missoula	59801	
Cooper	Pederson	Seattle	98101	
Candy	Lubar	Durham	27705	
Sarah	Hansen	Tacoma	98406	
Skyler	Schwendeman	Seattle	98101	

Austin	Pellerbruch	Renton	98055	
Alex	Hemke	Seattle	98118	Please leave this park alone!
Konrad	Peterson	Redmond	98052	
Caitlin	Pellerbruch	Renton	98055	
William	Kingman	Sumner	98390	
Bryan	Shanahan	Morganville	(0)7751	Save the rugby pitch!
Sam	Bruening	Fort wayne	46805	
Bryan	Smith	Seattle	98103	
Unpublished name		Gig Harbor	92506	Open space is a must for mental health and physical fitness. Trees help clean up the mess of pollution created by cars and airplanes. We don’t need more concrete in the Seattle area.
Unpublished name		Lake Stevens	98119	I've played on this field many years back and it is home to so many past present and future rugby players. Many parks won't allow rugby on their fields due to the stress the cleats can put on the grounds. We have to preserve this field, for future youth and men's leagues to come.
Teja	Henry	Riverside	43907	Please save our parks!
Dave	Schyberg	Seattle	93422	
			98003	
Stuart	Heavilin	Cadiz	98374	
Erik	Madsen	Atascadero	98335	People need more parks, outdoor fields, and open spaces!
Shannell	Ulu	Federal way	98024	Please don't take away from the kids
Erica	Black	Fall city	98258	
Donn	Gallon	Kotlik	99620	When I worked at SEATAC airport going over and watching the rugby matches after work was a great relaxer. Please allow this tradition to confinue. Pat Ryan field is a great community resource. Do not take it away.
Candice	Elms	Renton	98059	
Alden	Kroll	Seattle	98136	There are not many local greenspaces that can accommodate such variety of community uses. This area is an important space for individuals in the community to gather, explore, exercise, and just be out in nature.
Ryan	Young	Seattle	98115	
Nathan	Holmes	North Bend	98045	

Joseph	Gartner	Austin	78741	This field is used to home a family of rugby teams, and in doing so creates a community which brings together people from a wide range of socioeconomic and ethnic backgrounds. This community builds empathy and friendship across these divides. The beauty of Washington is the integration of it's natural beauty with a vibrant city. While it is understandable that the airport and it's need to expand are important to the greater Seattle-Tacoma area, it should not come at the expense of this beauty and the places that make people love calling Seattle home.
Matthew	Beaderstadt	Burien	98168	We live 5 blocks to the north of the Disc Golf section of the park and were delighted to discover an entire section of forested walking paths connecting to the Botanical Garden. This is a really great park and it would be terrible to see it destroyed and paved over.
Erin	Jensen	Renton	98059	
Melody	Glasgow	Portland	97206	As a member or Portland's rugby community, I travel regularly to play Seattle teams at this park (as do many othe people from the Pac NW area). The options for playing club rugby in Seattle are already extremely limited. Several different clubs play at this park. Please don't destroy it!
Anais	Cauchi	Issaquah	98027	
Megan	Krug	Issaquah	98029	
Leah	Vanderhyden	Issaquah	98027	
Justin	Widlund	Seattle	98144	
Alyson	Clow	Charlottetown, Canada	C1A5A3	
Joseph	Jeffries	Palm Beach	33417	
Keith	Rudie	Des Moines	98198	This area is beloved by the community and if this was a predominantly white and wealthy area, it wouldn't be threatened. This area is too important to the surrounding area. By preserving this section, it shows that you can for the community. For once do something that is courageous.
shwet	maroo	SeaTac	98198	
Jim	Jeffers	Las Vegas	89141	Save the Rugby pitch
Eric	Duechle	Seattle	98107	Trees matter
Artem	Kasabov	Everett	98203	
Shannan	Lacey	Seatac	98188	
Melissa	Sibley	Seatac	98168	
Jessica	Moore	Redmond	98052	Please save this wonderful park and the opportunities it provides for youth.

Colin	Pearson	Auburn	98092	Pat Ryan memorial field is a place that holds many fond memories from my youth - years playing rugby, as well as coaching and refereeing in recent years. Hundreds of us have dedicated so many hours to restoring the field and area surrounding, to make this a place worth coming to for a fun filled game day Saturday, or for training. Please take into consideration the societal value that this field holds, and what it brings to the many communities surrounding it, when making decisions going forward. There are quite a few people in this community, and losing this space would be detrimental to the youth groups, and for the sport overall as it continues to develop. Thank you for taking the time to listen to us and we hope for the best. Cheers!
David	Bruck	Seattle	98144	
Nicole	Reeves	Renton	98059	
Tyler	McDonald	SeaTac	98188	
Ikani	Vaka	Seattle	98158	
eliott	el naggar	Bellevue	98008	
Daniel	Rivera	Kent	98042	
Jacob	Olsen	Joint Base Lewis-McChord	98433	
Lucius	Packard	Renton	98058	
Patrick	Flanagan	Seattle	98103	
Brian	Hall	Seattle	98118	
Matt	Baumgartner	Federal Way	98033	
Daniel	Skinner	Seattle	98108	
John	Greer	Lakewood	98498	
Jason	Groepper	Maple Valley	98038	We need our parks!!!
Kierstyn	Bissett	Monroe	98272	
Herman	Meyer	Seattle	98116	I am writing to express my deep concern about the proposal relating to the North SeaTac park. As a frequent visitor to the park, I have seen firsthand the positive impact it has on our community. The park provides a valuable green space where people can enjoy nature, exercise, and socialize. It is also a place where families can spend time together and create lasting memories. The loss of the park would not only be a blow to those who use it regularly but also to the environment, as it serves as an important habitat for wildlife. I urge you to reconsider this proposal and work towards finding alternative solutions that will allow the park to remain intact while still addressing the city's needs.
Cody	Riggs	Seattle	98178	
Leo	Berk	Seattle	98118	Prioritize the benefits of outdoor recreation. Space like this is a dwindling resource. Please don't turn this into warehouses.

Cassandra	Leonard	Seattle	98136	North SeaTac is a unique space that creates opportunity for sport, community, health, well being and family fun. The network of trails and secret paths where you might come across an owl feeding her three baby owlets has been a joy for my family to explore for the past 13 years.
Latrena	Waller	Tukwila	98168	
Mark	Orr	Seattle	98112	
Deborah	Chambers	Redmond	98053	Place save Pat Ryan Memorial park as a dedicated rugby field for our community
Walker	Bohannan	Seattle	98115	
Treavor	Matsushima	Seattle	98119	
Kelly	Ring	Seattle	98102	
Daniel	Jordan	Seatlle	98125	
Thor	Hoyte	Lacey	98516	
Sarah	Schoenfeldt	Seattle	98118	
Guy	Lacey	Seatac	98188	This place is a haven for families. Please leave it be.
Kelly	Dunn	Seattle	98118	
Forest	Hoag	Seattle	98117	
Karine	Valliant-Saunders	Seattle	98122	
F Levi	Danzer	Kent	98042	
Sterling	Quinn	Seattle	98144	
Forrest	Murphy	Seattle	98112	North SeaTac Park is an amazing resource, not only for the residents of SeaTac, but for the wider region. It provides recreation opportunities not found anywhere else in the greater Seattle area, such as mountain bike trails, rugby fields, P-patch, and a BMX track. Park users and local residents have devoted thousands of hours of labor over the last decade to transform this vacant and abandoned land into a vibrant part of their community. They believed they were building a permanent asset for the City and the region. Please don't betray that promise.
Aaron	Erbeck	Seattle	98103	In no uncertain terms this park and the use of the trails for mountain biking have played a critical role in my family’s ability to recreate together and stay bonded with each other and our community. I will fight the development of or encroachment on this community resource.
Darnell	Umagat	Renton	98055	
Tracey	Gramenz	Seattle	98103	My family deeply values this park and the bike community we have created as a result of racing here. It is vital to our friend community and I will continue to support measures with my votes, volunteer time and actions to keep it a great space for our community.
Alan	Pavkovic	Maple Valley	98038	Please do not change North SeaTac Park. The trails that criss-cross the park are amazing!

Chad	Ronaldson	Normandy Park	98166	Not sure what your plan is and why you would take away from the hiking, biking, track, football, dog walking community. I can't think of any other piece of multi use property other than Swan Creek. If anything, we should invest in the property like Swan Creek has. One of the best BMX tracks is up front, why not make a better track in the back with nice shelters, bathrooms etc?
Yasmine	Scego	Federal Way		
Dawn	Hassel	Woodinville	98072	I race here every Wednesday night, the park is important to the cycling community!
Randy	Salamon	Tacoma	98407	
Don	McAuslan	Seattle, WA	98117	
Christopher	Fast	Seattle	98115	The airport already contributes a significant amount of air pollution to the Seatac area. The Port should be encouraging airport users and employees to use public transportation and should not be contemplating additional parking lots.
Michael	Cosentino	Tacoma	98407	Manage your money better.
Justin	Resnick	Seattle	98144	
Daniel	Jordan	Seattle	98125	
MATT	MESSENGER	SEATTLE	98105	
Brian	Marr	Seattle	98103	Removing some of the few urban green spaces we have to create more parking is a horrible decision that will impact generations to come. I'm all for economic progress and growth, but think about the role you are personally playing here. Think about yourself when you were young, and how you'd look at yourself today - are you a Goonie or are you the villain trying to pave over the city? Go up, not out. There are so few green spaces in our city.
Alasdair	Turner	Seattle	98115	
Gabe	Hajiani	Seattle	98102	
Jacobus	Saperstein	Seattle	98117	Preserving greenspace and coniferous forests should be a top priority.
Unpublished name		Renton	98059	I've played rugby at that field so many times and it'll be shame to see it go. The community will disband and be in shambles. It provides a safe place for so many families to come together and share the sport. It'll be so sad to see it go
Lorene	Mattingley	Ferndale	98248	
Royal	Smalley	Seattle	98177	Save this field for RUGBY!!
Jodie	Ramey	Seattle	98116	
Nicholas	Punimata	Lacey	98516	
Renee	Connor	Renton	98956	
Jon	Meads	Kirkland	98033	
William	Wiseman	Mercer Island	98040	This space is so important for youth sports. Pat Ryan Field is the only dedicated rugby pitch in King County. Excellent BMX and mountain bike trails. We need to preserve these green spaces for our youth athletes!

Barbara	Connor	Renton	98059	Please research the value of this rugby field and what this rugby community is all about. Invaluable opportunities to the youth reaching far beyond the immediate area you are trying to eliminate. Plesse.
Tim	Davenport	Bellingham	98225	
James	Hamilton	Measham, UK	DE12 7sb	
Jeff	Blakley	Port Ludlow	98365	Good day. Having lived in King County for 33 years, 1989-2022, I appreciated the open spaces available to all of us. I also have seen the loss of these spaces, large and small, and respectively urge the Port to maintain North SeaTac Park. Thank you, Jeff Blakley
Mollie	Gandy	Ferndale	98248	Please let this field stay! We love going and playing rugby there. It is an amazing place for kids from all over to get together with a sport they love and stay active!
Gregory	Gandy	Ferndale	98248	Save Pat Ryan Field!
Angie	Retz	Belly	98227	
Simkn	Dodd	Renton	98059	
Addie	Cappello	Mount Vernon	98273	Please stop taking away green space. Public spaces are places for people to recreate and get outdoors. If we keep developing these areas we won't have anywhere to actually be outside- except in parking lots. The valley rugby team deserves to keep their pitch. Stop bandaiding urban sprawl problems and deal with airport traffic issues in a more productive manner. Green up transportation and invest in climate friendly options. Thank you.
Angie	Spence	Auburn	98001	Options for outside lifestyles=HEALTH!
Hope	Sabiston	Ferndale	98248	
peter	giese	seattle	98116	Save the Park!
Ian	Meeks	Bellingham	98226	
Nathaniel	Bess	Shoreline	98177	
Patti	Cutler garcia	Renton	98059	Please stop taking land away from the kids!
Thomas	Soto	Benton City	99352	
Jordan	Wiseman	Mercer Island	98040	
Christina	Newell	Bellingham	98226	
Julie	Martin	Maple Valley	98038	
Robert	Lauren	Seattle	98121	
Courtney	Holmes	Bellingham	98229	This field is home to Liberty Rugby Club. SO MANY youth and adult teams rely on the use of this park and so many teams that play with team Liberty (ex Chuckanut Bay Rugby) want to help protect our friends from losing their home turf. In fact, they deserve a field that is graded and flat with adequate restrooms, so rather than taking this land from them, please provide them with the resources they deserve.

Sandy	Wisecarver	Blaine	98230	My son plays rugby on this field. It is the only field in King County. Rugby is important for the development of young men and women. It teaches them respect, how to behave themselves on and off the field. The coaches also ensure the youth keep their grades up and keep active when in the off season. Please keep our rugby field in King County!
Kels	Foote	Covington	98042	
Francis	Paulat	Burien	98168	
Leslie	Connor	Renton	98056	
Kevin	Graham	Mill Creek	98012	
Brian	Power	Seattle	98121	Pat Ryan Memorial Field provides a dedicated playing field for the local rugby players from youth to the D1 and semi-professional level. It serves the players from low-income and marginalized communities. Without this park you are taking away space from those communities you have vowed to support. Please keep the field and spend some money to improve and update the services at that field.
Lilian	Overbeck	Winthrop	98862	This field is has been a staple to a lot of people for a long time. Having green space for the community should be of upmost importance to everyone. Please save North Sec Tac Park.
Gavin	Honey	Renton	98059	
Finnegan	Water	Duvall	98019	There are very few rugby pitches in the county and pat Ryan is one of the most important having so many memories made on it and it being such a important part of the rugby community in king county
Cole	Barger	Renton	98059	There is a large community at Pat Ryan field that has been self-sufficient for many years. The trials and tributes of our game live in the dirt that we continue playing on. Taking the field away would discontinue generations of previous and future camaraderies of rugby among kids and adults alike. This is a place where we set aside our problems with one another and settle our disputes in a orderly and entertaining manner. Let us continue to introduce this amazing environment to the people who have never experienced it.
Fenn	Kleven	Kirkland	98033	
Alipate	Tuilevuka	Lynnwood	98087	
William	Hefner	Seattle	85934	
Timothy	Taylor	Seattle	98117	
Penitiko	Yauvoli	Yauvoli	98001	To whom it may concern, Pat Ryan field has been a place I've enjoyed with my family. Not only did I play rugby on this field but my family would come out to cheer for me. It was also a place to take my Family to watch other rugby tournaments and training. My kids would enjoy running around the track and on the field. Please help save Pat Ryan field for it's a park that families can enjoy doing different type of activities. Thanks for your time!

Diana	Wiseman	Mercer Island	98040	Pat Ryan field and the surrounding park is the dedicated home to many rugby teams and events. I can not tell you what this sport means to so many youths and adults. They have limited options since you really just can't play rugby properly on a football field. The sport has a very diverse cultural membership. Please support our rugby community.
Jesse	Favia	Renton	98059	
Unpublished Name		Medina	98039	This park is utilized for low-impact, high-value recreational activities and also provides valuable green space/canopy to reduce the impact of emissions and urban heat retention.
Amanda	Funaro	Burien	98148	I live right next to North SeaTac Park. I run through here regularly. You would be not only hurting my emotional, mental and physical health with the installation of the parking lot, but also the environment in which residents truly enjoy. These trees provide habitat for our various local wildlife species. As a person with a BS from the University of Washington in wildlife conservation I must speak up for those who cannot. Also, SeaTac airport has the second largest parking lot in the world, and has the largest single roofing parking structure in the world. There is also a plethora of exisiting park and ride companies/spaces near the park and the airport. The city of Seattle has a fantastic public transportation system with the Seattle Light Rail having a stop directly at the airport and connecting to downtown Seattle, on top of numerous busses and shuttles. There are many solutions to the SeaTac parking problem that do not include taking away public park land to turn into environmentally unhealthy asphalt. One such solution is to work with rideshare companies like Lyft and Uber. A friend of mine who drives for Lyft says the company will not allow him to pick up anyone from SeaTac airport because his car does not get forty MPG. As someone who lives locally and commutes to downtown Seattle that is ridiculous! Especially considering downtown Seattle is approximately fifteen miles from the airport. In conclusion, a parking lot on the behalf of SeaTac airport will be detrimental to our local community and to environmental efforts.
Steven	Kennerley	Ferndale	98248	Our rugby club Chuckanut Rugby has been playing Liberty at their fields for many years and hope to continue this great relationship and playing grounds.
Tamara	Ingram	Bow	98232	Please save this field and preserve what has been all these years!
S	Sullivan	Bellingham	98225	

Claire	Bonin	Burien	98168	Please, do the right thing, save the park and take care of it. This community needs it, it is well used and creates a buffer we can't do without. Protect this green space for us now and future generations.
Connor	Lamb	Mercer Island	98040	
Nautilus	Heartleaf	Snoqualmie	98065	
Rusty	Jones	Des Moines	98198	Please stop chipping away at our green space as if we wouldn't notice. This take-a-little-green-space-away-here-and-there adds up fast. We need and want this protected green space in this land of concrete that is the SeaTac airport area. Hands off North SeaTac Park!! And leave Des Moines Creek Trail? No expansion or developments around the Score Jail.
bryan	willman	kirkland	98034	Higher density of buildings, air traffic, etc require keeping all the trees, parks, and fields - or our area will become uninhabitable.
Jacob	Brill	Missoula	59808	
Howard	Porter	Burien	98168	Please leave our forests alone !
Dylan	Lugar	Renton	98059	You take away this field, you take away generations of memories and heritage. Please dont do this.
Andrew	Schmidt	White Center	98146	let's not make things any worse for the people who live here, okay?
Brenda	Stensland	Seattle	98168	We only get one planet, lets treat it with respect.
Delaney	Corcoran	Seattle	98168	
Morgan	Chatterton	Renton	98059	
Luke	Kipnis	Seattle	98168	
Richard	Meyer	Spokane	99217	
Norman	Arnett	Bothell	98011	Pat Ryan field is one of the only dedicated Rugby pitches in the Seattle area. Rugby is the fastest growing sport in the country, so losing a place to grow the game would be a huge setback to Pacific Northwest youth and club rugby. Please leave our parks and green spaces as they are!
Royal	Smalley	Shoreline	98177	Save this field! Save the trees! Save rugby for kids!!
David	Whiteside	Kirkland	98033	
Hosanna	Tiauli	Kent	98032	
Emily	Colesworthy	Lakewood	98499	
Benjamin	Gunter	Snoqualmie	98065	
Jeff	Bonnett	Lake Stevens	98258	Please let green space continue to be green space
Andrea	Wiesemann	Sammamish	98075	
Linda	Schier	Eatonville	98328	
Michael	Puloka	Federal way	98023	
Bethany	Sui	Auburn	98002	

Axel	Iverson	Seattle	98118	
Toshiyuki	Okada	Kent	98032	
Laurie	Blakley	Port Ludlow	98365	
Jennifer	Nollkamper	Issaquah	98027	
Ann	Townsend	Bothell	98021	This has been essential to the running of the mens team and the numerous childrens teams that have spouted from the outreach of the mens team. This is a playing field that is needed by the rugby community at large
Jayme	Foifua	Des Moines	98198	
Samuel	Trumbull	Fife	98414	
Barry	Weiss	Seattle	98115	
Unpublished Name		Post Falls, ID	83854	The community built around the park and rugby pitch is so so special. I spent much of my life in the SeaTac area, and made many priceless memories at the rugby pitch. Please don't take this deeply cared for special place away from the community.
Zac	Duffey	Kent	98042	
Samantha	Baker	Maple Falls	98266	
LaDrea	Ford	Renton	98055	
Jeff	Line	Lacey	98503	
Sherri	Swanson	Kent	98030	
Anastasia	Blakley	Port Ludlow	98365	
Darrin	Scharffenorth	Redmond	98052	
Kenneth	Ringen	McMinnville	97128	
Scott	Acker	ALBANY	97322	
Theresa	Yong	Tavernier	33070	
Claire	Johnson	Tacoma	98407	
Courtney	Holmes	Bellingham	98229	Please don’t kill rugby at Pat Ryan Field! Team Liberty is our sister team and they will have no home field! If you are taking this space please provide them with the field they deserve nearby, one that has level ground and running water/restrooms.
Jadyn	Campbell	Federal Way	98023	
jason	whalen	Seattle	98136	
Daniel	Trierweiler	Seattle	98144	
Seq’hiya	Simmons	Tacoma	98404	
Rob	Norman	Burlington	98233	Pat Ryan Memorial Field is one of a few spaces that are dedicated to rugby to be played in the region. To lose this space would be detrimental to the sport, community, & more importantly the student athletes that are afforded the opportunity to call this pitch their home.

Rebecca	Norman	Burlington	98233	Save the parks for the kids that utilize this field.
Kyle	Peter	Puyallup	98375	
Molly	Krupa	Maple Valley	98038	
Malcolm	Nesbitt	Woodinville	98072	
Boris	Kogan	Camas	98607	Please keep north SeaTac park as a dedicated rugby field
Unpublished Name		Seattle	98146	This park is beloved by the rugby community and it would be devastating to the community to destroy this space. Please consider the harm you will cause and the voters who will never forget it.
Victor	Sisk	Kirkland	98034	This field has lots of memories, watching my son play rugby. The trails through the park and all the trees.
Walker	Heiling	Seattle	98144	
Gisele	Fox	Seattle	98113	
Lucy	Toner	Seattle	98195	
Michaela	Fournier	Seattle	98105	
Riley	Ramirez	Seattle	98105	
Sofia	Dreessen	Seattle	98105	
rachel	ellingwood	Seattle	98105	
Erin	Schobbe	Seattle	98105	
Zoe	Warren	Seattle	98105	
Gracia	Anderson	Seattle	98105	
Daniel	Bascom	Seattle	98108	
Patrick	Harper	Seattle	98105	
Fran	Shannon	Seattle	98105	
Kellie	Telis	Seattle	98116	
Vanessa	Reyes	Seattle	98105	
Alyssa	D'Mello	Seattle	98105	
Ella	Wilks	Seattle	98105	
Sandy	Reyes Tena	Seattle	98105	
Kate	Connelly	Seattle	98105	
Camille	Andrew	Seattle	98105	
Mikaela	Ebbeson	Des Moines	98198	
Emily	Sheppard	Seattle	98015	
Christian	Vargas	Seattle	98105	
Nina	Pursai	Seattle	98105	

Alexander	Cabebe	Tukwila	98188	
Emma	Haener	Seattle	98105	Save the park!!!
Ozi	Goldstein	Seattle	98103	
Victoria	Harmon	Seattle	98105	
Regina	Bautista	Tacoma	98445	
Sam	Ason	Seattle	98105	
Jonah	Dirks	Seattle	98105	
Averie	Vendelin	Seattle	98105	
Alana	Springer	Everett	98201	
Lily	Nordyke	Seattle	98105	
Jessica	Fragoso	Seattle	98105	
Sydney	Porter	Seattle	98105	To best support our state's climate action goals and the health of the public, rezone this space in commitment to the ethics of our city, state, and people.
Alina	Doan	Seattle	98106	
Mia	Lawson-Henze	Seattle	98105	
Shauntaya	Parker	Bremerton	98310	
Caitlin	Naqvi	Seattle	98105	
Emma	Freeman	Burien	98166	Parks create vital barriers from air pollution.
Karena	Iliakis	Seattle	98105	
ava	vaughan	Seattle	98195	
Levi	Rucka	Seattle	98105	
Annie	Schlanger	Seattle	98105	
Lyn	Tampi	Seattle	98105	
Jessica	Day	Seattle	98105	
Edgar	Vazquez	Seattle	98105	
Anya	Gavrylko	Seattle	98105	North Sea Tac park is an important existing environmental solution to the pollution from Sea Tac airport. Please protect it by turning it into a park! This is an important environmental Justice effort as well :)
Lars	Bergstrom	Seattle	98105	
Blake	Mason	Seattle	98105	
Julie	Shafer	Seattle	98195	

Tracey	Heil	Camas	98607	This park is critical to the health and emotional wellbeing of the culturally diverse and marginalized citizens who live around it. Please change the zoning from aviation commercial to Parks land (given that it's historical use has been that if a park, after all) and enrich the lives of those who live nearby and future generations to follow. Thank you for your consideration and support.
Tia	Vontver	Seattle	98105	
Steve	Leigh	Seattle	98122	
Mary	Paynter	Des Moines	98198	I live near Woodmont Beach. Planes pass directly over my house 18 hours a day. And now the Port is planning to expand airport capacity to meet demand, predicted to be double what it is today. I am asking that the Port live up to the expressed intent of partially compensating residents of this area for the disproportional impact of aviation by preserving North Sea-Tac Park. Please! We need these trees! And with climate change observably here and affecting all of us in one way or another, we have to find an alternative to doubling the airport capacity. Trains! Virtual meetings! Only essential travel.
Steven	Hunt	Renton	98059	
Arnold	Liati	Snoqualmie	98065	My family really enjoys the use of the SeaTac park for picnicking, walking, and mountain biking. Please allow it to remain for the community as a natural park.
Kathleen	Sayan Scott	Des Moines	98198	
Stan	Berge	Des Moines	98198	
Traci	Buxton	Des Moines	98198	
Gene	Achziger	Des Moines	98198	
Doreen	Harper	Des Moines	98198	
Steve	Kearns	Des Moines	98198	
Harry	Steinmetz	Des Moines	98198	
Rick	Johnson	Redondo	98198	
Howard	Ferguson	Seattle	98108	
Tina	Nelson	Des Moines	98198	
Fekadu	Tuli	Seattle	98118	
David	Puki	Tukwila	98188	
Adrian	Wright	Kent	98030	
Roger	Kadeg	SeaTac	98188	
Gerald	Divis	Des Moines	98198	
Susan	Dedinsky	Des Moines	98198	
Penley	Leonard	Des Moines	98198	
Robert	Leonard	Des Moines	98198	

Kevin	Scott	Des Moines	98198	
Brandi	Ault	Shoreline	98155	
Corrigan	Murphy	Kent	98032	
Sarah	Janssen	Kent	98032	
Marcia	Bennison	Seattle	98133	
David	Matthews	Edmonds	98020	
Janice	Fisher	Seattle	98115	
Judi	Samuel	Seattle	98133	
Cindy	Ervin	Seattle	98115	
Garet	Munger	Seattle	98125	
Tom	Kress	Seattle	98105	
Anita	Gras Bryant	Seattle	98105	
Helen	Emery	Seattle	98103	
Carol	Warner	Seattle	98103	
Julie	Carnst	Edmnds	98020	
June	Saty	Seattle	98125	
Michael	Collins	Lynnwood	98036	
Margarita	Muñoz	Seattle	98103	
Maralyn	Wall	Seattle	98199	
Cary	LaMoth	Seattle	98103	
Joan	Weiss	Seattle	98118	
Andrew	Kidde	Seattle	98118	
Michele	Catalano	Seattle	98122	
Jerilyn	Twydell	Bellevue	98008	
Josephine	Weise	Shoreline	98155	
Abigail	Houghton	Seattle	98118	
Jacob	Leavitt	Seattle	98144	
Luz	Bratcher	Seattle	98146	
Erin	Shinneman	Seattle	98178	
Christina	Bearer	Seattle	98103	
Athena	Bautista	Seattle	98136	
Gary	McNeil	Des Moines	98198	
Sherry	Edwards	Des Moines	98198	

Paul	Hood	Burien	98146	
Sean	Cargill	SeaTac	98168	
Damien	Quartz	Seattle	98112	I do not agree with growth at the expense of the local community.
Clay	Compton	Bellevue	98004	
Theresa	LaRue	Seattle	98199	
Brian	Millican	SeaTac	98188	Please hear our voices on this matter!
Spencer	Rawls	Seattle	98122	
Liam	Galloway	Seattle	98116	
Leslie	Galloway	Federal Way	98003	
Alex	Andrade	Burien	98166	We used to live right next door and my kids grew up in this park. We need to be better about protecting green spaces for the health of all of us who live in, near, or around this area but especially this area as it's a filter to reducing harmful pollutants from its neighbor - the airport.
Rebecca	Carpenter	Burien	98168	
Doug	Uhl	Mountlake Terrace	98043	
Glenna	Foreman	Burien	98166	
Jesse	Linville	SeaTac	98168	
Kristen	Faiferlick	Seattle	98115	
Alejandra	Cromer	Seattle	98103	
Jared	Rodriguez Cortez	Bothell	98012	Keep up the good work!
Sarah	Campbell	Tacoma	98444	
Todd	Stoltey	Seattle	98101	
Dan	Langholff	Mill Creek	98012	
Jayson	Gregory	Seattle	98103	
Nate	Wallen	tacoma	98409	Save seatac disc golf!
Craij	Johnson	Orting	98360	
Patrick	Hutchins	Seattle		The Port of Seattle hopes to be one of the most sustainable in North America. Demonstrate that commitment by preserving North SeaTac Park, and supporting tree canopy restoration around the airport!
Miko	Russell	Burien	98168	
Jack	Gronholz	Seattle	98119	
Anders	Wennstig	Lake Forest Park	98155	I have spent over 10 weeks in the last year serving the community of SeaTac through the Washington Conservation Corps to help restore the forest in North SeaTac Park. The forest area here is much more important to the community than any amount of development and the forest must be protected.

Emanuel	Tesfaye	Seattle	98105	
Allison	Greely	Burien	98146	
Sybil	Davis	Burien	98148	Please know that the health of the populations ALL around the airport relies on clean air partially supported by a tree canopy, and green spaces. Please do not destroy that. We are all speaking out respectfully, please hear us. We have had so much taken away already. Do the right thing. Thank you.
Scout	Woods	Seattle	98168	
Risa	Askerooth	Seattle	98118	
STEPHANIE	BELL	Seatac	98198	I have lived in SeaTac since 2014 and have been deeply demoralized how many green spaces have been clearcut all around me in that short time. This when the climate catastrophe is only amplifying all around is and every tree matters more than ever to all of us for so many reasons. I am one of many thousands of local citizens who have signed a petition to beg the port/commission to preserve the trees in and around our precious green spaces which cool our neighborhoods, offer wildlife vital habitat, reduce air pollution around the airport, and increase our collective mental health. No surprise, the presence of and access to green spaces is also associated with reductions in crime. Urban blight serves none of us well and that should be reflected in public policy and decision making. We must save our green spaces, all of our lives depend upon this.
Isabelle	Feraudo	Seattle	98103	
Alicia	Fregozo	Seattle	98115	
Alexa	Fortuna	Shoreline	98133	
Allison	Greely	Burien	98146	
Anne	Siems	Seattle	98117	Do the right thing
Amy	Cirio	Tacoma	98406	
Kenneth	Anderson	Seattle	98115	There is plenty of underutilized parking lots and other existing paved space that can be converted into multistory commercial buildings.
Andi	Scher	Seattle	98103	
Angela	Dahl	Seattle	98146	My kids and dogs love this park. We walk here in the sun, rain, and even the snow. It was turned into a park for a reason. Do the right thing.
ashley	cohen lewe	seattle	98107	
brandon	shain	Seattle	98107	

Bridget	Hoffman	Seattle	98107	How is Seattle in need of more commercial buildings? It seems that the only city “progress” we have are apartment buildings after apartment buildings being built that have not been totally filled and empty business under neath them. And in a time where the mass population would prefer to work from home … how are more business parks the right answer ? Even Amazon cannot fill the muti million dollar properties it invested in because people … WANT TO WORK FROM HOME. This project sounds like another idea to line some developers, who probably is not based out of Seattle, pockets. Save our trees. We like to go by the emerald city for a reason. Don’t steal our trees.
Bruce	Dahl	Burien	98166	
Cristin	Mattione	Shoreline	98133	
Carolyn	Rubenkonig	Edmonds	98026	We need trees. To remain "The Evergreen State", we need to prioritize retaining forests and mature trees everywhere; especially urban and suburban environments where trees are threatened by thoughtless development.
Jasper	Daly	Kenmore	98028	
Diane	Lee	Burien	98148	Save the park - find other suitable land or utilize buildings that are standing vacant!
Ethan	Bickel	Seattle	98112	
Gabe	DeVet-Adair	Shoreline	98155	
Gabrielle	Rafert	Burien	98146	
Alanna	Hart	Seattle	98106	
Saulute	Wright	Marysville	98271	We need the trees!!! Don’t cut down any that aren’t sick!!!
Jade	Getz	Seattle	98122	
Juliet	Shen	Seattle	98115	
Katrina	Burrows	Lynnwood	98036	
Kelsey	Mines	Seattle	98133	
Kim	Maynard	Seattle	98136	
Kristina	Krause	Seattle	98103	Please save this forest, there is other land.
LeTania	Severe	Seattle	98112	
Lloyd	Lytle Jr.	Des Moines	98198	
Lauren	Moseman	Tacoma	98405	
L	Lin	Seattle	98125	We need to preserve these mature, native trees. They are a free, incredibly low maintenance resource to preserve quality of life (including factors related to the economy).
ashley	shain	seattle	98107	
Mark	Pedini	Burien	98166	
Marnie	Cowell	Burien	98166	

Brittany	Mellander	Renton	98055	We need trees for oxygen. The airport is bad enough, keep our health in in your thoughts!
Megan	Tully	Seattle	98133	
Mahogany	Tucker	Renton	98058	
Carmen	Moreno	Seattle	98103	
Morgan	Illig	Carnation	98014	
Mireia	Ravell	Mountlake Terrace	98043	
Nancy	Peterson	Des Moines	98198	Look at the Science and make studies completely transparent! and open to the public
Niko	Bhagwandin	Covington	98042	Support our climate by saving our climate. We as a community need to preserve the forests as they are. Every tree makes a difference and makes our stare a better place to live and thrive in.
Vanessa	Skantze	Seattle	98134	
Sarah	Nau	Seattle	98125	
Stefanie	Fatooh	Seattle	98168	
Michael	Dyal	Maple Valley	98038	The Valley Kangaroo Rugby Club plays here. I have played with and supported the club for years. Keep the field, they're are few options for our community to play regularly on a rugby field
Tony	Collier	Burien	98168	Protect the wildlife in SeaTac PARK NOW!!!
Jacob	Delbridge	Burien	98168	
June	BlueSpruce	Seattle	98118	
Allyson	Brown	Tacoma	98407	Keep SeaTac natural !!!!
Breaker	Chittenden	Seattle	98122	
Lindsey	Cahill	Des Moines	98198	I grew up right off Des Moines Memorial Drive, and greatly used this park. Please don't build over it!
DeAnne	Falls	Renton	98056	
Liz	Jenkins	Burien	98148	
Kaylee	Andrews	Seattle	98107	
Josie	Painter-McCullough	Burien	98168	

Karissa	Kleps	Burien	98168	We walk our dogs here every day and chose to buy our home specifically within walking distance of this park. As someone who works at the airport and around airlines, it would be such a shame to get rid of trees and other non toxic natural elements especially when most airlines are planning to have no carbon emissions within the next decade or two. It would be a step backwards in protecting and encouraging nature preservation that the Port of Seattle prides itself in. Putting in commercial buildings directly goes against the Port's environmental goals and is extremely hypocritical. This change is counterintuitive to what they publicly have posted on their website: "The Port of Seattle targets its investments and programs to reduce the impacts of development and protect our natural resources. As environmental stewards, we embrace our responsibility to our citizens, to the livability of this region, and to the future." Moreover, developing unnatural buildings would harm the neighborhood and overall natural environment and ecosystem that many people and animals rely on and enjoy.
Sarah	Zook	Seattle	98133	
Kristen	Chesmore	Bellevue	98008	Trees and open space parks are essential to human thriving in our state. Please preserve this space.
Patty	Horne-Brine	Burien	98166	Please leave the beautiful green canopy of this spot for families and anyone in the public to enjoy, as well as preserve the mature trees that exist here! What is all the talk about preserving trees, and then changing that to "well we will add trees to what we do?" meaning start over with saplings. It makes no sense! We need our forests!
Esther	Bui	Seattle	98168	
Theresa	Bearden	Seattle	98109	
Julia	Shure	Seattle	98108	
Bethany	Foutz	Burien	98166	
Emily	Kuhn	SeaTac	98168	Please save North SeaTac park- all of it. It is a space for our community to flourish and experience beauty, health, and peace. This is a vital part of our community and should be protected at all costs.
Rebekah	Ambo	Renton	98056	

Amy	Hitchens	Des Moines	98158	I grew up in Boulevard Park. I remember the Port making a promise to the wider community that this space would remain a park/green space for the people. Reneging on a promise is a bad look; we have long memories in the Highline area as well. The Port must be held accountable. We need our tree canopy. We need our parks. The Port needs to do their part to not continually be the worst neighbor. With climate change and the higher air traffic and longer wait times at pick up and drop off at the airport (car emissions too), we have more air pollution sitting in the atmosphere on more clear weather days. It is terrible for those who suffer from asthma. I know, I live adjacent to the 3rd runway. The Port has so much mitigation work to do. You can start by giving this park to the City.
Jude	Velez	Seattle	98105	
Jenny	Phan	Burien	98168	
Evelyn	Watson	Des Moines	98198	
Paul	Nguyen	Sumner	98390	
KAYLA	SALISBURY	Burien	98168	North Seatac park is my home 💝
Sadie	Ciccia-Strain	Seattle	98144	This park is such a special place for our youth. As someone who worked for a youth outdoor org, I have spent lots of time taking students of all ages to bike, hike, and play in this park after school. WE NEED THIS PARK TO BE PROTECTED. Please do whatever you can to fight to save this park from being developed. I've witnessed so many kids experience joy and friendship in this beautiful land.
Patricia	Murphy	Seattle	98103	We cannot afford to lose more trees! Period!
Eleanor	Peterson	Bellevue	98007	
Maria	Manza	Seattle	98101	Please preserve this important air pollution fighting ecosystem to protect the health of Seatac's residents. This is also an important wildlife refuge.
Meggan	Andrew	Des Moines	98198	
Doha	Sidahmed	SeaTac	98188	
Marlene	Barajas	Kent	98032	
Genesis	Agreda Marin	Burien	98146	
Isabella	Le	Seattle	98146	
Christine	Doan	Seattle	98146	
Madelyn	Hollister	Seattle	98106	
Paul	Young	Normandy park	98166	

Breanna	Battle	Tacoma	98402	
Makenna	Cowan	Burien	98166	
Natasa	Dukic	Seatac	98188	
Suzy	Dukic	Seatac	98188	
Gabriela	Duenez	seatac	98188	
Rian	Morgan	Des Moines	98198	
Turner	Bradcliff	SeaTac	98168	Dear Port of Seattle. Please don't develop at the North SeaTac Park. The trees provide oxygen to the residents of this area to breath. Seattle in general is already being de-forested too much with the expansion of people moving here. There are way too many trees getting cut down and this takes away from the health of everyone who lives here. Also, people come from many places to enjoy this park. Burien, Seattle proper, Tacoma, and many other locations. The soccer fields, the trails, the baseball fields, the lake, the freesbee golf course the places for people to come and have a picnic, the play structures for kids, the vast area for dogs to walk in, are all apart of people's daily, weekly, monthly enjoyment. So many people come here everyday and by taking this away you would help to destroy the enjoyment of so many people.
				Thanks for listening.
Tony	Atwood	Burien	98166	
Pedro	Sanchez	Burien	98148	
Alexia	Guajardo	Everett	98204	Please keep the seatac park community forest. It is a traditional thing to keep for our next generation
Menelik	Hailu	Seatac	98168	
Julian	Lucatero	Burien	98168	I use this park almost every day to walk my dogs! Taking it would greatly reduce the quality of life of not only mine and my dogs but everybody else who uses it. WE WANT IT TO STAY!!!
Allana	Gallagher	Seattle	98168	
Curtis	Anderson	Seattle	98105	The Port of Seattle pushed people out of their homes to build the airport, and now the same marginalized community members of North SeaTac have reclaimed this land for a public green space: North SeaTac park. If you guys took one second, pulled your thick skulls out of your check books, and took a walk in the park you'd see the foundations of former homes of pre-seatac residents. Do not take this park from us like you uprooted those lives. These aren't your trees for the taking. Enough is enough. Commercialize on your own land, on top, and inside of, your own terminals. Thanks!
Corbyn	Smith	Seattle	98168	
Gregory	Lorin	Seattle	98126	

Tom	Lewis	West Seattle	98136-1629	
kristina	lenss	lake forest park	98155	
Mckenna	Cross	Federal way	98023	
Daniel	Wear	Seattle	98122	
Brendalyn	Pastores	Seattle	98106	
Rose	Calderon	Des Moines	98198	
Brandon	Shults	Burien	98168	
Erika	Lara	White Center	98146	
Rebeca	Salinas	SeaTac	98198	Leave the parks alone. We don’t need more buildings. Use the buildings you officials have already torn down other parks for.
Karely	Nunez	seatac	98188	
Steve	Lozada	Burien	98169	
Erick	Bedolla	Burien	98168	
Cecilia	Martindale	Seattle	98122	I support measures to improve air quality in this neighborhood, especially given the potential for pollutants to contribute to chronic neurological disease
Malina	Garcia	Des Moines	98198	
Jackelyn	Andres	Seatac	98188	
Alejandro	Flores	Burien	98168	This park is iconic for the little walking trails the forest provides as well as all the little adventures people have when going to this park. cutting down this land would be a huge lost to the community!
Ruby	O	Tukwila	98168	This is a community that brings families together. Open land for the public and a wonderful place for parents to bring their kids. I know high school events happen here and many sports events are held here. Over the years it had been well taken care of and now more families walk this park. I have been coming to this park in the last 7 years. For this land to disappear and be of use of something else is very heartbreaking. Not only that but it is one of many parks that actually have trials to walk around and nature unlike just a park and basketball . Please rethink your position in this park- I understand more space for more possible housing but preserved land for the use of peace and activeness is needed here.
Gisselle	Alonzo	Burien	98168	
Jennifer	Victoriano Marquez	Seattle	98188	
Bella	Ramos	Seattle	98116	

Adriana	Alfaro	Des Moines	98198	I'm pretty sure y'all are profiting enough with all of the surrounding commercial buildings in seatac/ Des Moines, greed is really real and y'all just happy to make a fat check, typical though right, humans can't even enjoy natures gift without some greedy selfish business wanting to profit. Let us enjoy the gift we didn't create, who are we to be a higher being to take away something that's beneficial to our biodiversity of this community!?
yvonne	mmata	seatac	98188	
Barbara	Bernard	Seattle	98199	
Sarahi	Lopez	Seattle	98168	
Juan	Vazquez	Fife	98424	
Alma	Lopez aguayo	Seattle	98108	Please don't cut down this beautiful forest and make the park smaller, it's rare to have free community areas and you are trying to take this one away.
Julissa	Nevarez	Burien	98168	
Jasmine	Alvarado-Salinas	Seattle	98146	
Leslie	Gonzalez	Puyallup	98375	
Natalia	Murillo	Burien	98168	
Maria	Arevalo-Martinez	Burien	98168	This park is special to my multi-generational household. During COVID we started family runs. Green spaces are sparse in the south end of Seattle, we should aim to maintain this rather than continue to build infrastructure. Compare north Seattle to south Seattle…. They have a lot of green space, we deserve it too.
Brianne	Garcia	Boulevard Park	98168	Please preserve our park. My family and I are long time goers of this park and do not see another park nearby of this quality and green for miles. This park in its entirety is used every single day, sun, rain, snow doesn't matter. So many people of the community use its park, fields, and trails as a connection and it would be a complete shame to disconnect one of the only community areas nearby. Please rethink this decision and consider the people who truly care and use North SeaTac Park.
Samira	Brown	SeaTac	98198	Please LEAVE THE SEATAC PARK ALONE !! MY CHILDREN GREW UP PLAYING AT THAT PARK. This will break my toddlers hearts. My city is beautiful the way it is. Tell the outsiders to go back home please.
Patricia	Goldan	SeaTac	98198	This is where I wrote my business plan, this park helped me become a business women. It allowed me to let my ideas ROAM FREE! This is the park I found my husband (LOVE OF MY LIFE). I met him about 8 years ago and he was helping keep the park clean. This is where I took my graduation photos. My dogs love running wild in this park. Basically , I built my life here . AND I refuse to stand by and allow my community to be crashed.
Eliseo	Juan	Seattle	98168	
Yasmin	Malvaes	Burien	98146	
Angelina	Villalobos	Burien	98168	

Christina	Bergman	Seattle	98106	
Alanis	Baluyot McNeal	Seattle	98168	save our park!
Gabriela	Martinez Ruiz	SeaTac	98198	
Joel	Esqueda	Burien	98168	
Elizabeth	Coffman	Everett	98208	Please save this park the community and its wildlife NEED this park to stay healthy and happy. There should be ZERO acres taken from it for commercial building.
Sophia	Lanctot	Richmond	23223	
Alexis	Rios	Seattle	98103	Please stop cutting down and reducing land. We are so limited to parks with land and beautiful trees, for the sake of the mental health of many that use this park as a breather from the concrete world and work.
Mason	Fletcher	Seattle	98134	
Sharon	Arnold	Seattle	98178	We are at a critical time in our region, when climate change is impacting our urban ecosystems, affecting both human and animal life in adverse ways. Protecting our urban forests is more important than ever, as they offer not just shelter, food, and shade for wildlife, contributing to our area's biodiversity; but also provide benefit to humans as well. They capture carbon, provide oxygen, cool down the area in summer, and provide air filtration to keep ithe air clean and breathable--an increasingly important factor in South Seattle and outlying areas in close proximity to industry and major airports. We need to be protecting these refuges, not destroying them. We are asking that you do not clear cut this valuable nature reserve to build commercial buildings.
Serina	Lopez	Seattle	98136	
Dylan	Birch	SeaTac	98188	
Joey	Gonzalez	Tukwila	98168	
Erykah	Landreth	Tukwila	98168	
Ardina	Boll	Seattle	98102	
Joelle	Stephens	Lakewood	98499	
Valerie	Tran	Burien	98148	
Jazmin	Higuera Banos	Renton	98056	
Emma	Hernandez	Burien	98146	
Faith	Villalobos	Burien	98166	
Betty	Cheng	Seattle	98118	
Han	Chuang	Issaquah	98029	
Megan	Harmon	Carnation	98014	
edina	jupic	Burien	98168	

Maya	Ramirez	Federal Way	98023	This is a beautiful park. But it's not only a park, it's also a home. A home to local plants and animals, to some it's the last place they were with someone who's no longer here, and to others a place that always reminds them of good / positive memories. It's not just a park but somewhere you can run to in the middle of the city yet feel like you're deep in the forest. Why would you destroy and take more if Mother Nature. The man/humans take take and take. But when the trees start dying, and the air becomes even MORE polluted the buildings you guys plan on building won't be able to do anything for you, for us. Why would displace animals and destroy a whole ecosystem just for your selfish monetary needs. It's repulsive. Leave the park as it is. Leave it alone.
Tiffany	Nguyen	Burien	98146	
Veronica	Urbina Acosta	SeaTac	98188	
Kenny	Vo	Tukwila	98168	
Helen	Olivares	Seatac	98198	
Martha	Molina	Federal way	98003	
Paige	Unke	Burien	98148	
Ashleen	O'Brien	Seattle	98108	
Di	Ramirez-Diaz	Tukwila	98168	
Leilani	Meas	Burien	98168	
Aiden	Dowling	Seatac	98168	these acres of tree and trails hold so many valuable memories to me, my family, and so many others in the community especially the disk golfers.
Miranda	Hernández	SeaTac	98188	
Angela	Zapata	Burien	98166	
Quin	Hopkins	Seattle	98116	
Jonathan	Jaime	Tacoma	98499	We NEED THIS PLACE!
Bob	Smith	Seattle	98104	
Alessandra	Guerrero-Aviles	Mercer Island	98040	
Kevin	Andrew	Kent	98032	
Lucas	Pham	Seattle	98168	
Charisma	Whitten	Tacoma	98409	
Kaitlin	Elliott	Burien	98166	
Jasmin	Machado	Kent	98032	I grew up going to North Seatac Park with my family, ocasionally had birthday parties there. Played volleyball with my family. Did barbeques, and played on the playground. Please keep N Seatac Park in place, to continue making memories
Nabila	Comstock	Tacoma	98422	
Kemberly	Garcia	BURIEN	98168	

Michelle	Rojas	Renton	98056	
Zaid	Alhamawendi	Burien	98168	
Shayna	Mclane	Burien	98168	
Angel	Sampson	Kent	98032	
Beck	Gilmore	Tukwila	98168	
Jacob	Sarb	Seattle	98106	
Julia	Shettler	Seattle	98115	
Kristen	Smith	Seattle	98126	
Sara	Silaj	River Grove	60171	
Fernando	Gallegos	Seatac	98168	
Rebecca	Helland	Seattle	98195	
Sam	Miller	Kent	98030	
thika	thay	seattle	98168	save north seatac park!!
Ema	Fawadi	Burien	98146	
Kelly	Merlo	Tukwila	98168	
Britta	Kleitsch	Burien	98166	
Elham	Fawadi	Burien	98146	
Ryan	Wayne	Seatac	98188	Parks are a huge attraction as well as pivotal for the wellness of the civil community. Leave this park alone.
Kayla	Hoang	Burien	98168	
Jessica	Nichols	Seattle	98168	
Arcelia	R	Burien	98168	We LOVE North Seatac Park!! Leave the park alone!!!
Harkarn	Bains	Burien	98168	
Yessica	Bello	Seatac	98188	
Justin	Balas	Puyallup	98375	
Judoth	Growing Thunder	Burien	98168	Dont do it. The plants are sacred, the land is sacred. This belongs to the people. The community. Theres memories and childhoods that were and still being made here. Dont take away the one good place the community has to feel peace.
Vedansh	Chhabra	Burien	98168	DONT TAKE MY PARK AWAY

Eduardo	Garcia	Tukwila	98168	I'm absolutely saddened to see it's profit over life that habitat has been a key place to the community I am now 31 years old but that park all the memories me and my friends have let alone all the other people in the community, all those tree that help with scientifically proven harmful emissions from jet fuel that will have a impact in the community that will be unrepairable, I get everything in this world is about a cone and making more profit but for once can you guys listen to the people and not tear down the community thank you for reading this
Shandiny	Contreras	Seattle	98125	I urge all parties to invest in preserving North SeaTac park in its entirety. Nature, community health and land preservation are values and practices that I witness time and time being central to communities cross-culturally.
Caroline	Tran	Burien	98168	
Sovanny	Suong	Seatac	98168	Hi! Im 23 and I just bought my very first home in the same neighborhood as the north SeaTac park because I wanted to stay close to my childhood home but this is the area that I lived in all my life. The park is super close to my home, not only do I not want commercial buildings right behind my house but I genuinely love the park and trail still. This would be a major change for not only me but my family as well!
Elenh	Corrales	Seattle	98169	In part of the community please don't remove half of the park. The park is much more valued is where people go and unwind after a long day. The fresh air from the trees are fundamental.
Zeljka	Jurcevic	Auburn	98092	This is one of the only big parks in the south end! It is a park I, and many others frequent with their dogs throughout the year. It provides ample walking space and much needed shade that is often not available in other areas. This park is an integral part of the community. Please do not alter it!
Elis	Johannessen	Seattle	98106	
Karissa	Kolman	Tacoma	98444	
Gary	Manfredi	Lake Forest Park	98155	
John	Kolman	Federal Way WA	98023	Save the trees and the park.
Jorge	Velazco	SeaTac	98168	
Anahi	Ortiz Martinez	Seattle	98168	
Aunisty	Mendoza	Burien	98148	
Rosario	Rivas	Tukwila	98188	
Sara	Arevalo	Tukwila	98188	I want to express my strong opposition to the proposed plan to cut down our local forest near the SeaTac airport. Our community values this green space. As Washingtonians cutting down local forests we risk losing the essence of our states identity as the "Evergreen state". Port of Seattle, be a part of our natural heritage and uphold the same values the community shares.
Elizabeth	Hurd	Seattle	98105	Do the right thing! Protect the environment!!
kirby	bui	seattle	98146	

brandon	Rivera	Seatac	98188	
Amrit	Singh	Seatac	98188	
ashton	snyder	mercer island	98040	Save the park
Mira	Stemen	SeaTac	98188	
Macayla	Marsden	Corvallis	97330	
Hal	McManus	Kent	98030	
Kristina	Rodney	Seattle	98117	
Emmanuel	Cruz	Burien	98168	
Gurnoor	Kaur	Seattle	98103	
Lillian	Diaz	Seattle	98101	
Leila	Le	Renton	98055	
Hector	Ramirez	BURIEN	98167	This park is a staple to the community
Ripenpreet	Thind	Seatac	98168	
Gerardo	Hernandez	Burien	98146	
Michelle	Elkins	Maple valley	98038	As a SeaTac native, I am saddened to hear of the proposal from the Port of Seattle. SeaTac and Burien already have the burden of pollutants, noise, and negativeveiws of airplanes. So many community members benefit from this park. Also, crime rates can also increase once people don't have a positive green space in their community. Please consider your impacts on people in these communities.
Debbie	Mcwain	Burien	98148	Save what little parks we have left, too much housing and structures.
Angela	Temple	Seattle	98168	There’s already so few good parks. To also gift land then want to take it back is atrocious. Capitalistic greed to just want to develop it.
Kyle	Herbruger	Seattle	98105	
Irina	Kramaruk	Auburn	98092	
Itzel	Montoya	Burien	98148	
Erica	Olson	Seattle	98122	
Bernarda	Quijano	Seatac	98168	
Bee	Nieves	Renton	98058	
Elizabeth	Sykes	Burien	98166	
Delilah	AW	Des moines	98198	
Ana	Ramirez	Pacific	98047	
Amy	Xia	Seattle	98105	

Jennifer	Dahl	Burien	98166	For once, the port should live up to its agreements with the community. Greenspace was promised. Greenspace should remain. And then, there is the issue with only using the third runway during inclement weather….
Yuri	Nakashima	Seattle	98168	
Lesley	Baeza	Seatac	98188	
Martin	Salinas	SeaTac	98198	Don’t take away the park!
Emily	Lopez	Tukwila	98168	
Courtney	Wright	Federal way	98003	
Dinnielle	Dumot	Renton	98058	
Jacob	Jones	Tukwila	98168	You pollute our water and air. You pollute our skies with unending sound. We will not let you take our trees.
John	Bennitt	Bellevue	98007	
Thaddeus	Driscoll	Seattle	98144	We are in an time of increasing public and political awarness of the value of urban and community. We need to take steps forward not backwards in the development of our cities. North SeaTac park is a hidden gem that should remain as an asset to the community. It also could be the site of increased forestry and ecological work and could qualify and be a resource fo federal IRA funding specifically for the alotment to urban and community forestry.
Maria	King	Seattle	98144	
Felicia	Newhouse	Seattle	98126	
Peter	Kane	Olympia	98501	SeaTac park is a gem, please preserve it, there are too few trees left.
David	Green	Seatac	98148	This is a highly frequented area by both community members and local wildlife. Please prioritize this popular natural area.
Brett	Fush	Normandy Park	98166	I strongly believe that the Port was forced to offer these lands by the Courts as mitigation for the 3rd runway! The Supreme Court said do 100% of the mitigation 1st, then you can build. These warehouse proposals are completely contrary to the agreements and a back door inch by inch slow motion overturning of mitigation. Their thinking is apparent one will notice if the go slow. Shame on the Port!
Edwin	Obras	SeaTac	98188	
Charlie	Youngchild	Graham	98338	There are enough commercial buildings vacant not being utilized that need to be addressed before building more. Don't take away more nature that brings more people joy and mental health peace than any building would.
Patrick	McCann	Seattle	98117	

Barbara	Leuty	Seattle	98112	
Roccy	Spadafore	Covington	98042	
Tramy	Nguyen	Burien	98168	
Manuela	Figueroa	Burien	98168	
Camille	Ritchie	Tukwila	98188	
Oliver	Reasoner	White Center	98146	
Deborah	Anderson	SeaTac	98188	Dear People in Power, I can't believe I am writing to beg you to save our trees for our future, We are in a 25% tree canopy situation in SeaTac already. We actually like living here. We don't want to be forced to move. Please consider that you have enough and work with that and work with us. *(Note: this is the second entry for this signer - included in order to publish this comment)*
Teresa	Cicrich-Powell	SeaTac	98188	
Latecia	Farrell	Renton	98059	Please let us keep our rugby pitch for our children and our community. The airport doesn't need any more land they're fine.
Marisa	Fulmer	SeaTac	98126	
Kim	Schwarzkopf	Seattle	98126	Please protect the trees! There is value in preserving our natural capital!
Kjersten	Gmeiner	Seattle	98125	
Melissa	Bernal	Seattle	98168	
Tonya	Carey	Lakewood	98498	
Darnall	Fuiava	Federal Way WA	98023	The more kids playing on fields like this, the less there are roaming the streets.
Roxana	Gomez	Normandy Park	98166	
Eric	Teachout	Renton	98056	
Mary	Johnson	Burien	98168	
Brian	Webber	Seattle	98116	
Marty	Smith	Bonney Lake	98391	
Ashe	Graves	Seattle	98118	
Elder	Cartagena	Burien	98147	
Tedros	Tsegay	Seattle	98168	
Donny	Rodgers	Sumner	98390	
Tyler	Points	Burien	98146	

Jacob	Bies	SeaTac	98168	
Najarel	Lewis	SeaTac	98168	
Todd	Watkins	Renton	98058	This park used to be full of blackberry bushes, tall grass, weeds until the disc golf community built a course many years ago. Now it is beautiful, spacious, and provides many more places for folks to walk, play disc golf and enjoy nature. So, including the need for trees to suck carbon from the air in this high pollution zone (it's an approach for jets landing at SeaTac airport), it is many more things to many people.
Michael	Harshman, Jr.	SeaTac	98188	Keep trees! We walk with our grandkids and admire scenery and habitation
Virginia	Alfaro	SeaTac	98188	
Coral	Covington	SeaTac	98188	I have lived in SeaTac 19 years and love the forest. It provides oxygen! I love going for walks in our forest, I don't have to travel far to enjoy the great outdoors!
Jose	Martinez	SeaTac	98188	I love our forest! No more warehouses!
Nasheli	Martinez	SeaTac	98188	
Jasmine	Cosem	Burien	98168	
Arianna	Pacheco-Covington	SeaTac	98188	STAY AWAY FROM THIS LAND!!!!!!
Asma	Teezab	SeaTac	98188	
Sarah	Sami	SeaTac	98188	
Max	Frieda	White Center	98146	
Khadija	Teezab	SeaTac	98188	
Violeta	Vega	Seattle	98103	
Paul	Adler	Shoreline	98133	The Port of Seattle’s needs to protect North SeaTac Park for open space for the community and the environment.
Unpublished		Des Moines	98298	We have lived in Des Moines for 34 years and live directly below the 3rd runway flight path. The noise and disruption has a huge impact on our quality of life and we are increasingly concerned about air quality and the long term impact of plane related air pollution. We adamantly oppose additional Port of Seattle development that destroys green spaces and increases air traffic. I wish that Port Commissioners were required to spend an afternoon in our backyard during peak travel times. But apparently the health and quality of life needs of members of the surrounding communities are not factored into the Port's decisions.
Michele	Lewis	Burien	98146	It's time for the port to take some environmental responsibility by preserving natural areas around the airport. You have neglected the north SeaTac natural area for decades allowing invasive to take over. And you only propose more abuse of the land by expanding parking structures instead of building on existing lots that have already been deforested. You have a responsibility to the environment at large and to the well-being of people who live in the surrounding areas. Please start making environmentally responsible decisions about land use surrounding the airport.

Carrie	Pizzano	SeaTac	98188	
Jenessa	Hope	Seattle	98108	Save our forest. Save North SeaTac park and maintain it for future generations. Our health and well being depends on it.
Ian	Lawson	Seattle	98116	
April	Gambriell	Seattle	98108	
Alyson	Stoner-Rhoades	Seattle	98108	
Scott	Romine	Seattle	98106	
Atzhiri	Nava	Seattle	98108	
Lauren	Tran	Seattle	98108	
Dara	Elish	Seattle	98108	Please keep us green!
Jessamyn	Johnson	Seattle	98108	
Clay	Compton	Bellevue	98004	
Javiar	Mendez	Seattle	98108	
Anna	Pierce	Burien	98166	Our urban parks and forests are vital to a thriving city. The Port is a steward of such lands, and with that has a responsibility to preserve and uphold these precious places. A tree and a trail will serve generations to come; a parking space is flat, covered in oil and cracks over time. The problems of today will not be solved by sacrificing health and well being of our future.
Kali	Parrish	Seattle	98108	
Max	Lakritz	Seattle	98108	
Joelle	King	Seattle	98108	
Theresa	LaRue	Seattle	98199	
Erica	Evans	Seattle	98108	
Barbara	Miller	Seattle	98108	My family and pets are experiencing health issues from the airport. Stop taking the trees down. We need this to clean the air. How many more people have to have lung cancer or mental issues from the airplane pollution
Amanda	Hodges	Seattle	98108	For a state that claims to care about lower income families, minorities, and children, we do a lot of stuff like remove the one thing helping the air quality in these neighborhoods. Forests, trees and green spaces help combat the monumentus negative impacts people who live near airports face. Shorter lifespans, higher childhood asthma, learning struggles. The pollution harms the community. Trees help more than almost anything, yet our state doesn't put the lives and health of the citizens as a priority. This space needs to stay green and we need to make this a permanent change. Protect the green spaces and protect the citizens who are clearly valued least.
Amal	Grabinski	Seattle	98108	
Seanna	Jordan	Seattle	98108	

Daniel	Volkmann	SeaTac	98168	Stay green and help clean the air.
Susan	Davis	Seattle	98108	
Sandra	Pettit	Seatac	98188	Trees are beneficial to our environment, they help clean air and let's face it there are still many days and nights the fumes are unbearable not to mention the noise. I have lived here over 52 years, seen expansion of runways, a freeway replace a beautiful drive around a lake and lost many neighbors. Our community is expanding and traffic on S 152nd will be further impacted adding another layer of pollution. Please save our trees, fumes and sound barriers. Help us live healthier lives not go back in time
Tai	Gordon	Seatac	98168	
Patrick	Hains	Seatac	98168	
Patricia	Hernandez	Seatac	98168	My three boys grew up going to this park and now I bring my three grandchildren…. They love to walk through woods and trails …. This is our family park don't take it away
Clinton	Attaway	Burien	98168	
Gabriel	Lavalle	Lynnwood	98036	
Hannah	Casey	SeaTac	98168	It is vital to protect green space around the airport, for all of our health (humans and animals), for air quality, for noise reduction, and for maintaining desirability of living in this neighborhood.
Jaspreet	Singh	Seatac	98168	
Athena	Bautista	Seattle	98136	
Erin	Hazard	SeaTac	98168	I live here, I breathe here! Leave our trees alone!
Chey Anne	Tatum	SeaTac	98168	
Charles	Thom	SeaTac	98168	Love both love & am proud to live in an area with so many trees/green spaces, and want to keep it that way.
Izzy	Henson	Seattle	98178	
Emilie	Sovis	Seattle	98178	The forests and trees of Seattle make this city stand out among the rest of the entire country. No city in America offers such sanctuary amid such population. Please protect our parks, forests, and trees! Convenience or expediency can cost us for generations, and our city will thrive if protect the natural environment
Doe	Knotting	Seattle	98178	
Duane	Skipworth	SeaTac	98168	
Unpublished		SeaTac	98168	Save our trees in SeaTac. Community has sacrificed and eminent domain has eliminated a beautiful part of south king county area over a 50 year span.
Jeri	Hegeland	Seattle	98168	
Jim	Ace	Bellingham	98225	
Kristina	Rodney	Seattle	98115	
Stefanie	Berg	Burien	98166	

Annette	Anderson	Burien	98166	As a Burien resident my family, Grandchildren & I utilize the SEATAC park system. It is wonderful to enjoy the ecosystem & to protect & preserver this area & system for generations to come. You can't keep tearing down communities, forestries, ecosystems, wildlife to continue to support the expansion of SEATAC Airport. They have long since wore out their welcome. It's time to think about the citizens of your community & communities surrounding who have chosen to buy, rent or visit & to enjoy the wetlands, wildlife & public enjoyment of the area. Please DO NOT give in to this destruction. Please remember you represent the citizens of your community as well as the citizens of surrounding communities who utilize the park system itself. We need to continue to save the parks, forestries, wetlands, ecosystem, natural habitats & the wildlife that depend on this system.
Kelly	Rudie	Des Moines	98198	Other counties work beautifully to keep their areas around the airport's beautiful, respect the surrounding communities and help offset the carbon footprint caused by the airport. Seattle should as well. Our airport could lead the way in protecting the environment, beautifying the area and still make a profit! Be visionaries, not short sighted, deaf to the citizens, status quo leaders! Save our urban forests!
Clare	Parfitt	Des Moines	98198	
Susan	McIlwaine	SeaTac	98198	
Pam	Gaddis	Woodinville	98077	
Cassie	Geraghty	Federal Way	98023	We need to protect what safe green spaces we have left, for the health and benefit of our communities and the environment. This is a matter of environmental social justice.
Ramona	Gault	Shoreline	98133	We must balance industrial growth with a healthy environment. Cutting down trees won't help the environment.
Amanda	Lynn	Seattle	98126	Deforestation in the era of climate change is insane.
Ryan	Miller	Seattle	98118	I support this reasonable plan for saving one the few green spaces still available.
Catherine	Darwin	Seattle	98126	
Andrew	Tait	Seattle	98122	
John	Pound	Seattle	98101	
Todd	Stoltey	Seattle	98107	
Cat	Chun	Tukwila	98168	
Ian	Powell	Seattle	98168	
Shauna	Carlson	Burien	98168	
Eileen	Lambert	Des Moines	98168	
Kathy	McDonald	Des Moines	98168	
Rea	Rein	Seattle	98125	
Barbara	Gregory	Seattle	98115	
Guyanthony	Parramour	Seattle	98115	

Erica	Sanford	Kirkland	98115	
Carl	Gaddis	Woodinville	98077	Protect the Highline Forest - We can't easily replace this resouce once it's gone. We can more easily preserve and even expand the forest and its benefits to people and wildlife
Suzanne	Grant	Seattle	98119	
Anne	Green	Redmond	98052	
Scott	Granlund	Seattle	98118	
Chris	Thomsen	Burien	98146	
Frank	Roberson	Des Moines	98198	We don’t need any more warehouses…. Our goods that we purchase get to us as fast as we need them. It will congest our streets with even more traffic and they will be Semi’s.plus these building are hideous!!! It will push out even more of the wild life too. I thought we were a “green state”??? Carbon tax? But you cut down the one natural thing that absorbs carbon??? This is a joke! We want less traffic. Less ugly buildings. Less noise. Stop selling us out!
Lorena	Mejia Baldovino	Des Moines	98198	
Melissa	Stanley	Federal Way WA	98003	
Erika	Benner	Des Moines	98198	
Melissa	Traverso	Des Moines	98198	I support saving trees. We need this land for so many reasons. If we need to spend money on buildings then use it to improve the waterfront!
Brian	Volkert	Normandy Park	98166	
Sierra	Houk	Seattle	98118	
Janit	Calvo	Seattle	98168	We just can't curb the climate change if we keep chopping down our trees and forests and you know it. The north end of the city needs to share this burden. There is nothing "sustainable" about this "SAMP." After this expansion, there will be another and another. Please leave our existing forests and trees for our children's sake - or there simply won't be a future they can look forward to. We MUST leave them a better place to live.
Alyse	Brindle	Seattle	98168	
Jon	Hopkins	Seattle	98168	
Bruce	Dear	Seattle	98177	
Jennifer	Emery	Des Moines	98198	
Christen	Bourgeois	Federal Way	98023	