JOHN J. STRUNK

Due to a clerical error this number has been omitted.

POLLUTION CONTROL HEARINGS BOARD
FOR THE STATE OF WASHINGTON

AIRPORT COMMUNITIES COALITION and CITIZENS AGAINST SEA-TAC EXPANSION, Appellants, v. DEPARTMENT OF ECOLOGY and THE PORT OF SEATTLE, Respondents.	No. PCHB 01-160 **PREFILED TESTIMONY OF JOHN J. STRUNK**

INDEX OF TESTIMONY

AR 016649

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ORIGINAL

INTRODUCTION / SUMMARY OF TESTIMONY

1. This document submits my testimony to the Board in regard to PCHB No. 01-160, ACC and CASE versus Department of Ecology and Port of Seattle, Appeal of Section 401 Certification of the Third Runway construction project and related projects at the Seattle-Tacoma International Airport (STIA). My testimony will focus on the likelihood that ground water contamination at various sites at STIA will migrate to the Third Runway project area via preferential pathways.

2. It is my opinion that multiple lines of evidence indicate that the existing ground water contamination is contained to areas of the major release sites near the STIA aircraft operations and maintenance area (AOMA) and will not migrate to the Third Runway project area via perched groundwater zones, regional groundwater aquifers, utility trenches or via any other mechanisms. It is also my opinion that construction dewatering activities associated with subgrade improvements at the Third Runway project area will not alter the fate and transport of ground water contaminants at the AOMA area. Supporting conclusions for my opinion include:

- The major contamination source areas are located over one-half mile (2800 feet) from the Third Runway project area and this distance provides a more than adequate buffer.
- Ground water contamination is contained within the AOMA, the area of the airport where most aircraft fueling and maintenance operations have been performed. Extensive environmental investigations have been performed in the AOMA to define the nature and extent of soil and ground water contamination.
- The environmental data does not support the allegation by the appellants that contaminated ground water is migrating preferentially within backfill of subsurface utility lines such that it would impact the Third Runway project.

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- The layout of existing utility lines is very complex and circuitous, it is highly unlikely that any ground water within utility line backfill would eventually migrate to the Third Runway area.
- Geologic units that result in perched ground water conditions are discontinuous, and at some areas of the airport, absent altogether, thereby physically prohibiting the migration of perched ground water in those areas.
- The short term dewatering associated with Third Runway Embankment subgrade improvements will not impact the fate and transport of ground water contamination in the AOMA. Potential contamination sources associated with the home heating oil tanks in the Third Runway buyout areas have been cleaned up by remedial excavation activities. Concentrations of fuel products (total petroleum hydrocarbons) in ground water associated with releases from the home heating oil tanks have not been encountered above MTCA standards.

QUALIFICATIONS

3. I am a managing partner and Associate Geologist with Aspect Consulting, L.L.C. and specialize in the characterization of hazardous waste sites and ground water resource evaluation. I received a Bachelors of Arts degree in geology with a coordinate major in environmental studies from the University of Vermont in 1984. I have received supplemental training in the field of environmental sciences through the attendance of numerous professional seminars. I have over 17 years of professional experience which includes 13.5 years as a environmental consultant and 3.5 years of regulatory experience working for the State of Vermont Department of Environmental Conservation as a hydrogeologist in the Hazardous Materials Site Management Section.

4. I have been involved in environmental characterizations and remedial activities at STIA since 1991 which includes serving as the project manager for the following projects: Soil Remediation at the Former United Hangar Site, Ground Water Remedial Investigation/Feasibility Study at the Former United Hangar Site, Hydrogeologic Investigation

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at the Industrial Waste System Plant and Lagoons area, the MTCA Agreed Order STIA Ground Water Study and environmental support for the Third Runway construction project. I also manage an on-call contract through the Port of Seattle related to providing environmental review on various projects throughout STIA. Since 1995, I have been the project manager for the STIA Ground Water Study. My work for that study has included the evaluation of historic and known contamination sites within the AOMA of STIA, and an evaluation of their potential impact to regional ground water aquifers and local receptors. As part of this study our project team has developed a comprehensive environmental database which contains information on contaminants of concern and allows for mapping the distribution of ground water contamination in perched water bearing zones, as well as in the upper-most regional aquifer (Qva) beneath STIA. Recently, in June 2001, I completed an evaluation regarding the preferential movement of ground water and the ability of shallow ground water to migrate along subsurface utility line backfill (Associated Earth Sciences, Inc. (AESI), June 19, 2001, Draft Technical Memorandum, Analysis of Preferential Ground Water Flow Paths Relative to Proposed Third Runway, Seattle-Tacoma International Airport). I am currently in the process of implementing a monitoring plan, as required by Condition F.1. of the September 21, 2001 401 Certification, to further assess the ability of utility line backfill to transport contaminants towards the Third Runway project area, and, if necessary to develop a program to monitor this potential migration pathway.

ANALYSIS OF POTENTIAL MIGRATION OF STIA CONTAMINATION

Perched Groundwater Contamination

5. It is highly unlikely that perched ground water contamination at STIA will be affected by Third Runway construction or operation. This conclusion is based on the following findings.

6. Perched ground water conditions at STIA are discontinuous and localized. Shallow perched ground water is present in several discontinuous and localized areas within the AOMA and areas of the Third Runway project (Exhibit A: AESI, 2001, Fig. 3 & Fig. 6).

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The shallow perched ground water condition is a result of the presence of low permeability geological units, mainly glacial till (Exhibit A: AESI, 2001, Fig. 1). The till is present at depths ranging from near ground surface to about 40 feet below ground surface. The extent of the discontinuous perched ground water zones has been defined by subsurface borings and monitoring wells developed in association with numerous environmental and geotechnical projects throughout STIA.

7. The glacial till and perching conditions are not uniformly present below the AOMA, further reducing the likelihood of horizontal migration. Till is absent in several locations at STIA due to natural geologic processes, as well as historical construction related activities which appear to have breached the till unit. In general, areas where the till is absent or thin do not contain shallow perched ground water. The horizontal perched flow is typically localized and flows along the top surface of the glacial till unit. Ground water flow direction in the perched zones is highly variable and, in locations where it has been measured, it frequently flows in a direction away from the Third Runway (Exhibit A: AESI, 2001, Fig. 4). At some locations within the AOMA, multiple perched ground water levels have been observed, suggesting vertical components to ground water flow. Similarly, vertical ground water flow is suggested by the discontinuous nature of the glacial till.

8. The perched ground water zones within the AOMA are remotely located relative to the Third Runway. The Third Runway project location is approximately one-half mile (approximately 2800 feet) from the western AOMA boundary, and further still from areas of contamination identified within the AOMA (Exhibit A: AESI, 2001, Fig. 2 & Fig. 6). This distance provides an extensive horizontal buffer that isolates areas of contaminated perched ground water observed in the AOMA from the Third Runway construction area.

9. The main contamination source areas impacting perched ground water are contained within the AOMA. Contaminated ground water is present in the perched water bearing zones in isolated areas of the AOMA. Extensive environmental investigations conducted by the airlines, other airport tenants and the Port of Seattle have delineated the

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boundaries of contaminated ground water. The impacted ground water has remained localized and appears to be contained laterally to areas that are adjacent to the source releases, which are present within the AOMA boundary (Exhibit A: AESI, 2001, Fig. 3 & Fig. 4). The main contaminant source areas within the AOMA are typically the result of jet fuel releases from underground storage tank systems, fuel line hydrant systems or accidental releases. A small number of solvent releases have also been documented and characterized and are also contained within the AOMA. A large array of groundwater monitoring wells has been established to collect ground water samples and thereby define the boundaries of the impacted ground water at each of the individual release sites. Several remedial actions have been implemented, such as fuel product recovery, contaminated soil excavation and treatment, and active remedial treatment systems (ground water pump and treat systems, air sparging, bioventing, and other vapor extraction techniques), to reduce the contamination source and contain the impacted ground water. Additional remedial actions have been implemented during the construction phase of STIA capital improvement projects.

10. There is no indication that perched ground water contamination is migrating beyond the western boundary of the AOMA towards the Third Runway. Detailed environmental investigations have been performed along the western boundary of the AOMA in association with the decommissioning of old aircraft fuel systems (Exhibit A: AESI, 2001, Fig. 3). In some locations along the western boundary of the AOMA, soil borings have been completed at 100 foot intervals along the length of the fuel lines. Results of these investigations did not indicate perched ground water migrating beyond the western boundary of the AOMA. Further, the majority of soil samples collected at depth as part of this investigation indicated contaminant levels below MTCA standards.

Qva Aquifer Conditions

11. It is highly unlikely that contamination in the QVA aquifer will be affected by Third Runway construction or operation. This conclusion is based on the following findings.

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12. The Qva aquifer is the uppermost aquifer of regional extent and is located throughout STIA. The Qva aquifer is continuous throughout the AOMA and STIA and in most areas of STIA is classified as an unconfined aquifer. In some locations, it is interconnected with the underlying aquifer. Typical ground water flow in the Qva aquifer is to the west, varying from northwest to southwest as a result of influence of local discharge zones such as Miller Creek, Des Moines Creek and associated wetlands (Exhibit A: AESI, 2001, Fig. 2). Ground water in the Qva aquifer beneath the AOMA is encountered at about 60 to 90 feet below ground surface, with the variability primarily due to changes in surface elevation across STIA. The unsaturated region between the perching zone and ground water in the Qva aquifer is approximately 20 to 50 feet thick.

13. Impacted Qva ground water is well defined and remains within the AOMA boundary. Ground water monitoring wells completed in the downgradient direction from documented Qva impacted ground water sites indicate that contaminant concentrations are below regulatory standards and the wells provide a defined plume boundary delineating the extent of contaminated ground water (Exhibit A: AESI, 2001, Fig. 5). Development of the Third Runway is not likely to significantly impact or increase the migration of AOMA Qva ground water contamination. As stated earlier, the Third Runway project site is over one-half mile from the AOMA and activities associated with the construction of the Third Runway such as dewatering activities will not influence the ground water flow conditions or the fate and transport of contaminants in the Qva aquifer at the AOMA.

14. Soil and ground water contamination have been characterized properly to manage potential impacts to receptors and develop appropriate remedial response measures. In his declaration, Mr. Thomas Luster states:

> "The existing airport includes several areas of known or suspected soil and groundwater contamination that have not yet been adequately characterized to determine they are not affecting surface water."

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As stated earlier, the main contamination sources within the AOMA have been extensively investigated and appropriate remedial actions have been implemented to reduce and/or eliminate ongoing sources. Based on my review of contamination sources within the AOMA, there is no indication that soil or ground water contamination is currently affecting surface water or other receptors. Ground water impacted above Ecology Model Toxics Control Act (MTCA) standards are contained within the boundaries of the AOMA in both the perched water bearing zone and the Qva aquifer (Exhibit A: AESI, 2001, Fig. 3, Fig. 5, & Fig. 6). Furthermore, the Ground Water Study will provide numerical ground water flow and fate and transport modeling to further evaluate contaminant flow paths and provide a mechanism to site a long term ground water monitoring network. The Department of Ecology has been actively providing regulatory review oversight at each of the major contaminant release sites within the AOMA and has provided direction to the site characterization process in defining the nature and extent of ground water contamination.

15. Extensive environmental assessments and remedial actions have been conducted in association with home heating oil tanks sites in the Third Runway property acquisition areas. Cleanup actions have been implemented to remove localized shallow soil impacts resulting from heating oil tank releases. There is no indication of ground water impacts above MTCA standards resulting from any of the heating oil tank sites.

Subsurface Utility Pathways

16. <u>Environmental data do not indicate that the numerous subsurface utility lines within the AOMA are a preferred pathway of contaminant migration to the proposed Third Runway site</u>. This conclusion is supported by the following findings:

- Individual site investigations within the AOMA have demonstrated that ground water contaminants have not migrated significantly along underground utility lines or infrastructure.
- The majority of the underground utility lines are constructed at a shallow depth and the perched ground water elevation generally exceeds the typical depth of

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STIA utilities. Much of the perched ground water is vertically isolated from utility backfill areas (Exhibit A: AESI, 2001, Fig. 6 & Fig.7).

- Site investigation data indicate that the perched ground water is generally present in areas of underground storage tank backfill in areas of the AOMA. The perched water ground water flow direction in the AOMA is variable and frequently east and southeast away from the Third Runway project area.
- Multiple perching horizons have been observed at some sites which indicate a strong downward vertical component to perched ground water flow.
- Perched ground water conditions have been observed at the Third Runway area in recessional outwash deposits and or alluvial deposits overlying the glacial till unit. The alluvial deposits were generally not deposited in the uplands of the existing STIA runway area, and the recessional outwash deposits were removed from much of the STIA AOMA and existing runway areas during past site grading. The absence of recessional outwash and thick fill deposits in the central and western portion of the AOMA and existing runway areas, as well as the discontinuous nature of the glacial till unit suggests that a pathway for the migration of perched ground water from the AOMA to the Third Runway area does not exist (Exhibit A: AESI, 2001, Fig. 6).
- Further there are several areas at STIA where the glacial till unit is thin or absent. In areas where the till is absent there is no evidence of perching zones and vertical flow would predominate (Exhibit A: AESI, 2001, Fig. 1 & Fig. 6).
- The existing utility lines located at STIA consist of a complex array of underground structures that are circuitous and generally do not extend from the AOMA to the Third Runway project area (Exhibit A: AESI, 2001, Fig. 8). Changes in utility line elevation, lines that cross permeable geologic units, and complex flow pathways would all limit the ability of the utility line backfill to transmit contaminated water great distances.

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17. Construction of new utility lines associated with the proposed Third Runway will not provide a direct connection between the AOMA and Third Runway project area. Construction of the Third Runway includes the completion of only one utility, a new communications ductbank, between the AOMA and Third Runway project site (Exhibit A: AESI, 2001, Fig. 8). It is my understanding that the new communication ductbank ties directly into existing communications lines currently constructed for the existing runways. Therefore there will not be any new utility lines constructed directly between the Third Runway and contaminated areas of the AOMA.

18. The section of the new utility in closest proximity to the AOMA is not located in an area where perched ground water has been encountered or documented (Exhibit A: AESI, 2001, Fig. 8). The depth of the new ductbank is at about 4.5 feet, a higher elevation than typical measured perched ground water elevations observed elsewhere at the AOMA.

19. There is no deep infrastructure proposed that would establish a direct connection between the AOMA and the Third Runway area, and therefore create a preferred pathway for existing Qva ground water contamination to migrate to the Third Runway. New stormwater vaults are all located outside the AOMA and are not located in areas of documented soil and ground water contamination zones (Exhibit A: AESI, 2001, Fig. 8).

20. Best Management Practices (*see* next section) will be employed for all new utility construction that occurs within areas of the AOMA.

21. Best Management Practices (BMPs) used during the construction of new utility lines within the AOMA will prevent the migration of contaminated ground water. BMPs have been proposed as part of Condition F.1. of the 401 Permit. These BMPs are designed to prevent migration of contaminated ground water in newly constructed utility corridors. The BMPs will be included in construction contract specifications for future construction of subsurface utilities within the AOMA. Ecology has recently approved the Port's BMP proposal. The BMPs include:

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- Require contractor to dewater utility trenches and other construction excavations that contain contaminated ground water and dispose of water appropriately.
- Reduce the permeability of the trench backfill material by placement of a controlled density fill (a lean concrete mixture), or similar low permeability material into the entire utility trench, or, over a minimal depth of traditional utility bedding material.
- Where the controlled density fill is used over traditional utility bedding material, the full trench profile will be filled with control density fill dams at defined intervals along sections of utility trenches.

Implementation of the BMPs will provide physical barriers that will prevent the migration of ground water in newly constructed utility lines in areas of the AOMA where contaminated ground water is present.

Construction Dewatering

22. It is highly unlikely that construction dewatering associated with subgrade improvements for the Third Runway Embankment and MSE Walls will impact the fate and transport of ground water contamination. In ACC's pre-filed testimony, Mr. Edward Kavazanjian, Jr., Ph.D., P.E. states:

> ". . . construction dewatering may impact the fate and transport of contaminants beneath the airport operations and maintenance area and other parts of the airport property. Dewatering will draw groundwater from beneath the adjacent property towards and into the excavation. Groundwater drawn towards and into the excavation may include groundwater impacted by contaminants. Even if the impacted groundwater is not drawn into the excavation, the fate and transport of existing plumes of contaminated groundwater may be impacted by changes in groundwater flow patterns associated with dewatering. The Port has not presented any analysis of the potential impacts of excavation dewatering on the fate and transport of contaminated groundwater adjacent to the excavation."

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Mr. Kavazanjian further states that; "The zone in which dewatering activities drain water from . . . the wall may well extend 100 ft or more from the edge of the excavation (175 ft or more form the face of the wall) . . ." The Port of Seattle has recently evaluated the effects of construction dewatering related to subgrade improvements for portions of the Third Runway embankment (HNTB, Sea-Tac International Airport, Third Runway Embankment Construction, Subgrade Improvements for MSE Retaining Walls, February 2002). This evaluation considers potential impacts from construction activities below existing ground surface to provide stable foundations at three locations along the mechanically stabilized earth (MSE) retaining walls. The three areas requiring dewatering are located at the South MSE Wall, the West MSE Wall and the North MSE Wall. Each of these areas are located a substantial distance (between 0.5 mile to 1 mile) from contaminated ground water contained with the AOMA. Mr. Kavazanjian's expert opinion suggests that the maximum zone of influence that will occur during dewatering is limited to approximately 175 feet from the excavation boundary. In fact, in areas consisting fine grained soils, HNTB has concluded that the area of dewatering influence will only be about 80 feet from the excavation boundary.

23. The zone of dewatering influence will therefore not effect the movement of ground water contamination within the AOMA area which is over one-half mile from the dewatering excavations.

24. Potential contaminant source areas resulting from heating oil tanks within the buyout areas have been removed by clean up actions consisting of soil excavation to levels below MTCA cleanup levels or Ecology Interim TPH policy standards. There is no indication of ground water contamination above MTCA standards associated with the home heating oil tank sites. Several commercial properties have also been acquired by the Port and are located in the Third Runway construction area. However, these properties are located west of Miller Creek and at a distance that will not be influence by construction dewatering activities.

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I declare under penalty of perjury under the laws of the state of Washington that the foregoing is true and correct.

Executed at Bainbridge Island, Washington, this 6 day of March 2002.

John J. Strunk

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PRE-FILED TESTIMONY OF JOHN J. STRUNK

EXHIBITS

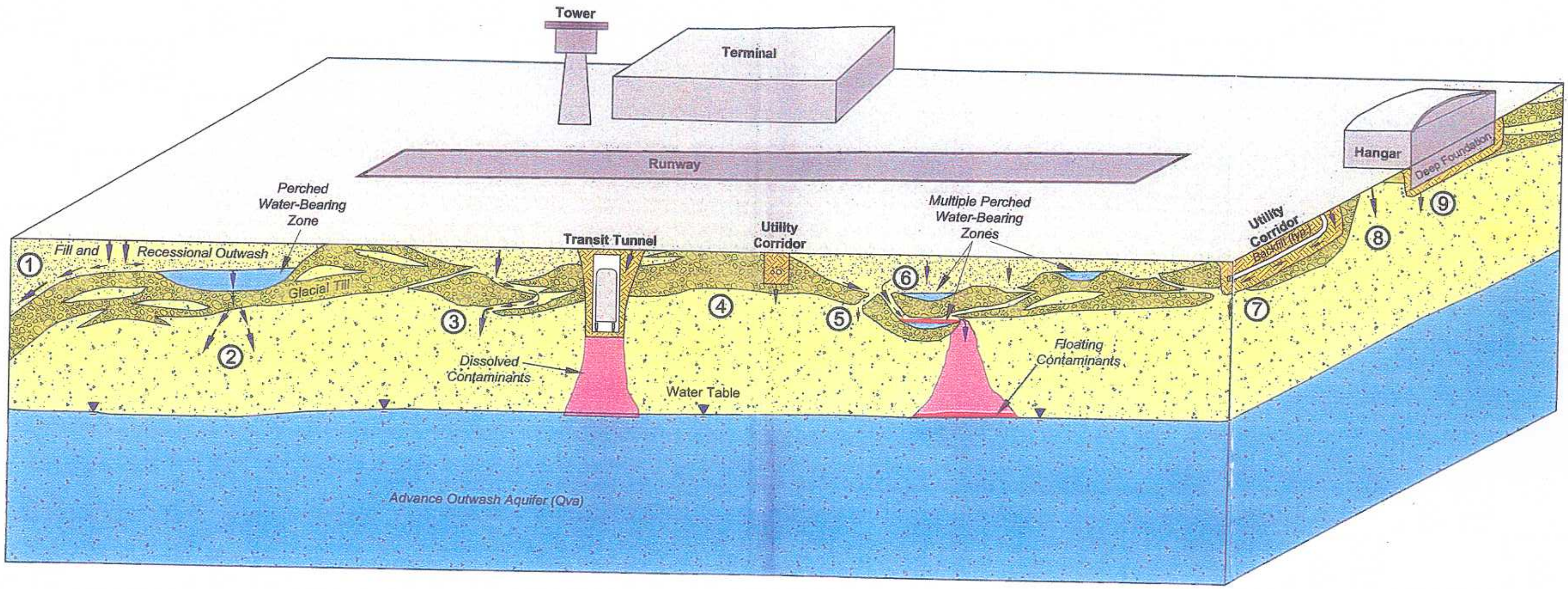
A	AESI, 2001, Fig. 3 and Fig. 6
B	Resume

Exhibit A

Conceptual Model of Potential Perched Ground Water Flow Paths

Seattle-Tacoma International Airport

Figure 1



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POSSIBLE PERCHED GROUND WATER FLOW PATHS ON AND THROUGH GLACIAL TILL

① Lateral migration on till surface - slow where slope is gentle, faster where slope is steep

② Slow seepage through till where perched

③ Flow where till is discontinuous or through sand and gravel lenses

④ Vertical flow through backfill for transit tunnels or utility corridors

⑤ Vertical flow where till was not deposited

⑥ Flow between multiple perched zones

⑦ Lateral flow along utility corridors

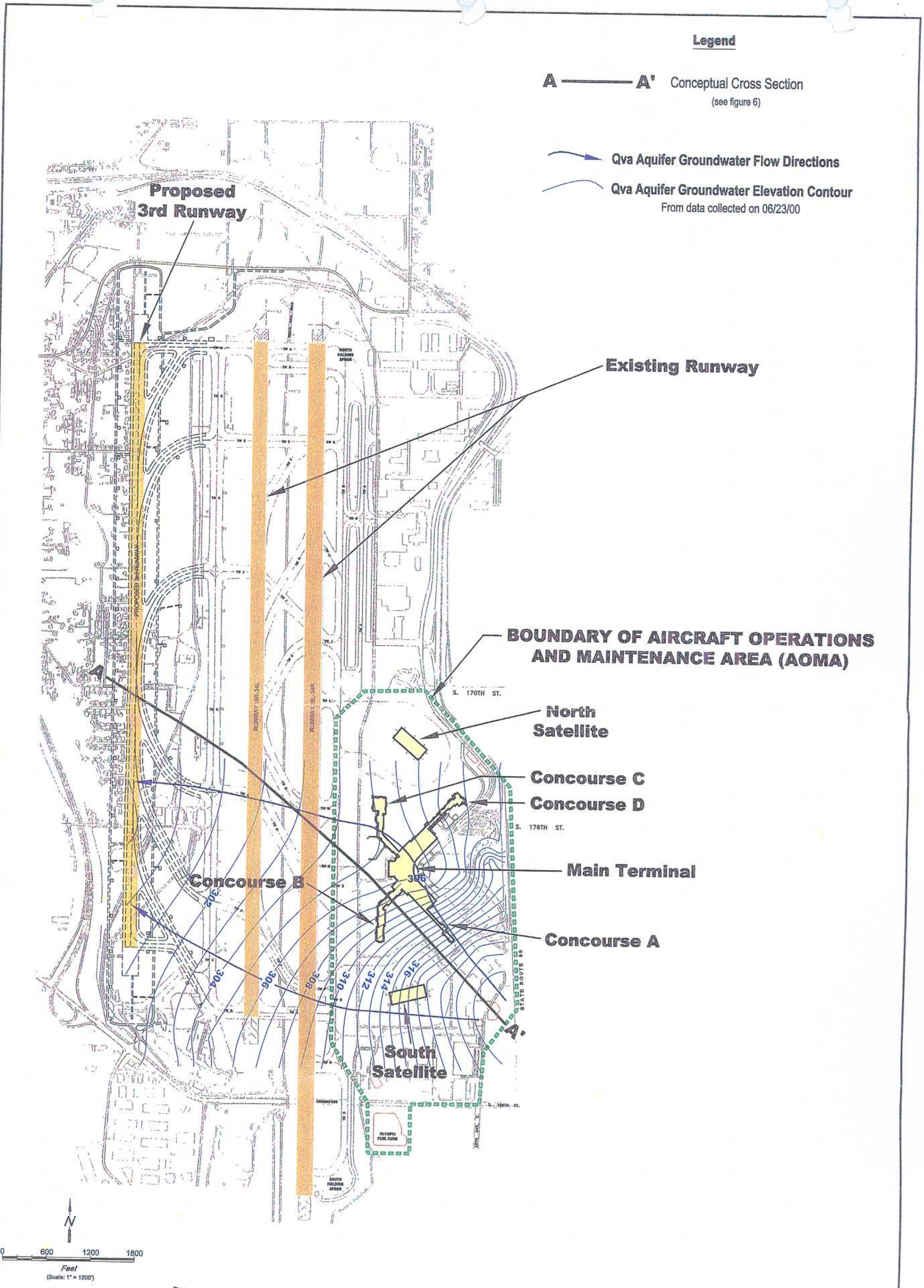
⑧ Vertical flow where till has been removed by grading

⑨ Flow where till has been penetrated by deep foundations

Potential Flow Path

- Relatively slow
- Relatively fast
- Floating Contaminants
- Dissolved Contaminants

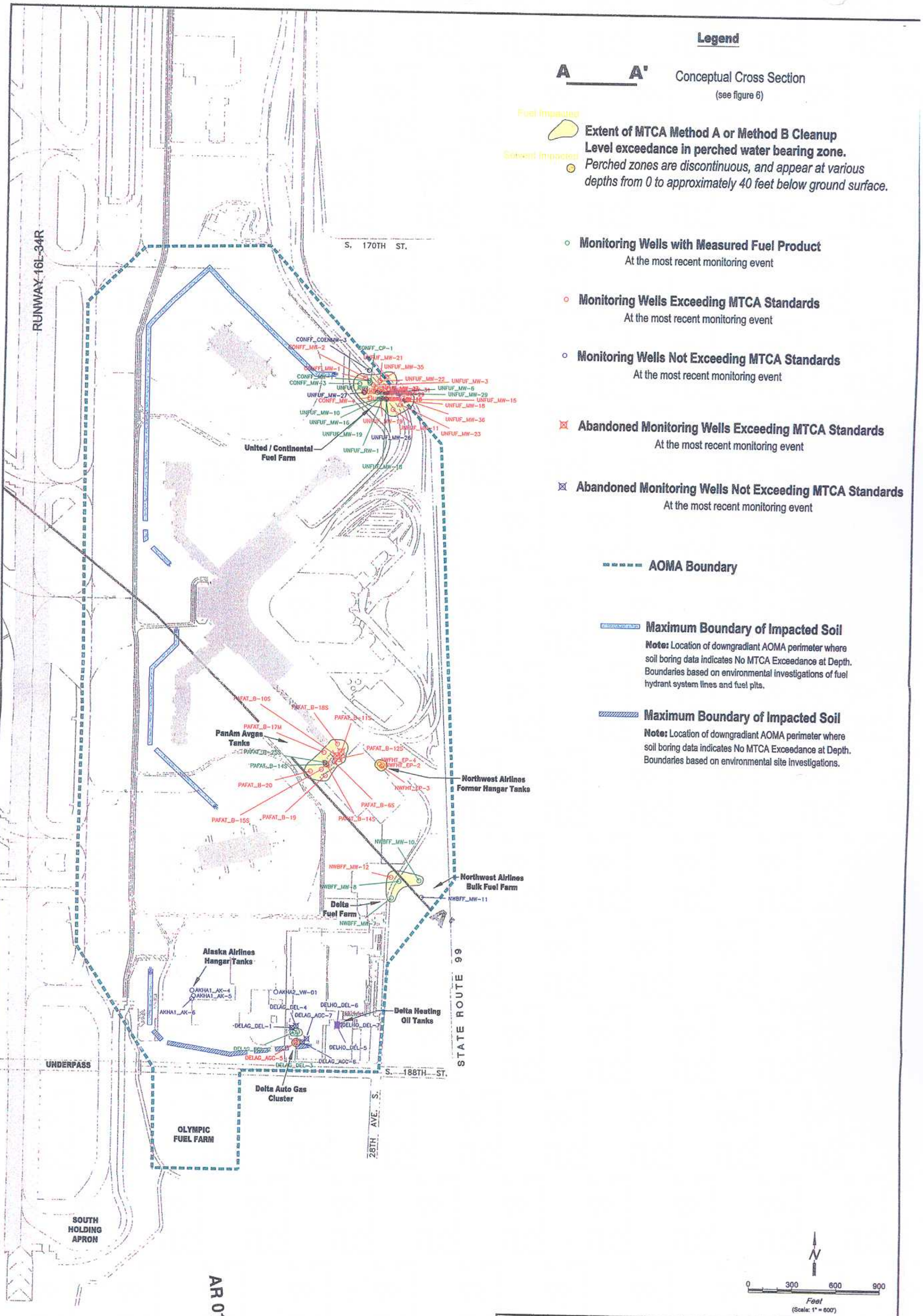
BV99122-CTN.dwg



Seattle Tacoma International Airport

Site Reference Map

DATE:	FILENAME:	FIGURE NO.
06/14/01	BV99122-RE.dwg	2

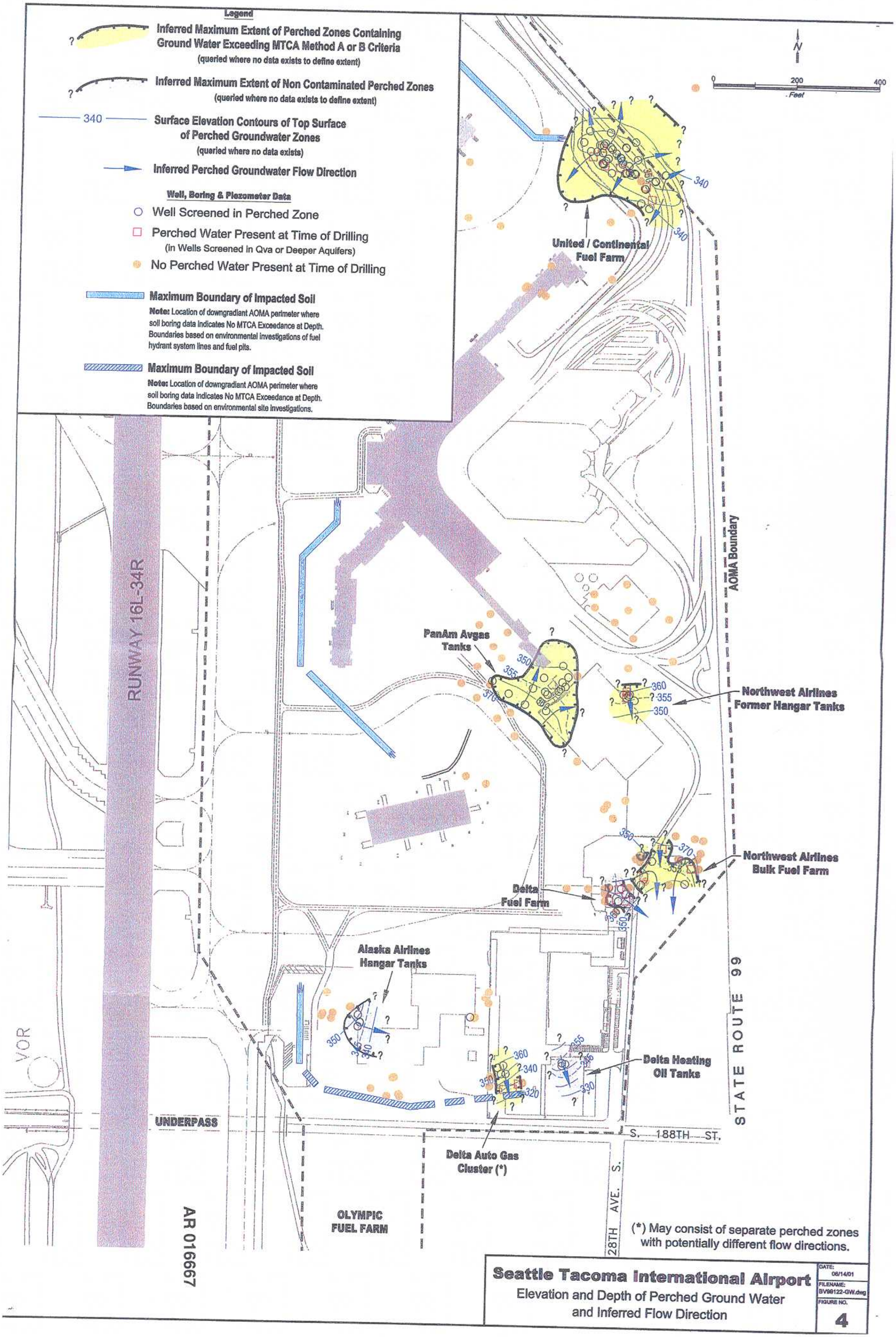


AR 016666

Seattle Tacoma International Airport

AOMA Wells in Perched Water Bearing Unit
W/ MTCA Ground Water Standard Exceedances

DATE:	08/21/01
FILENAME:	BV99122-Perched.dwg
FIGURE NO.	3



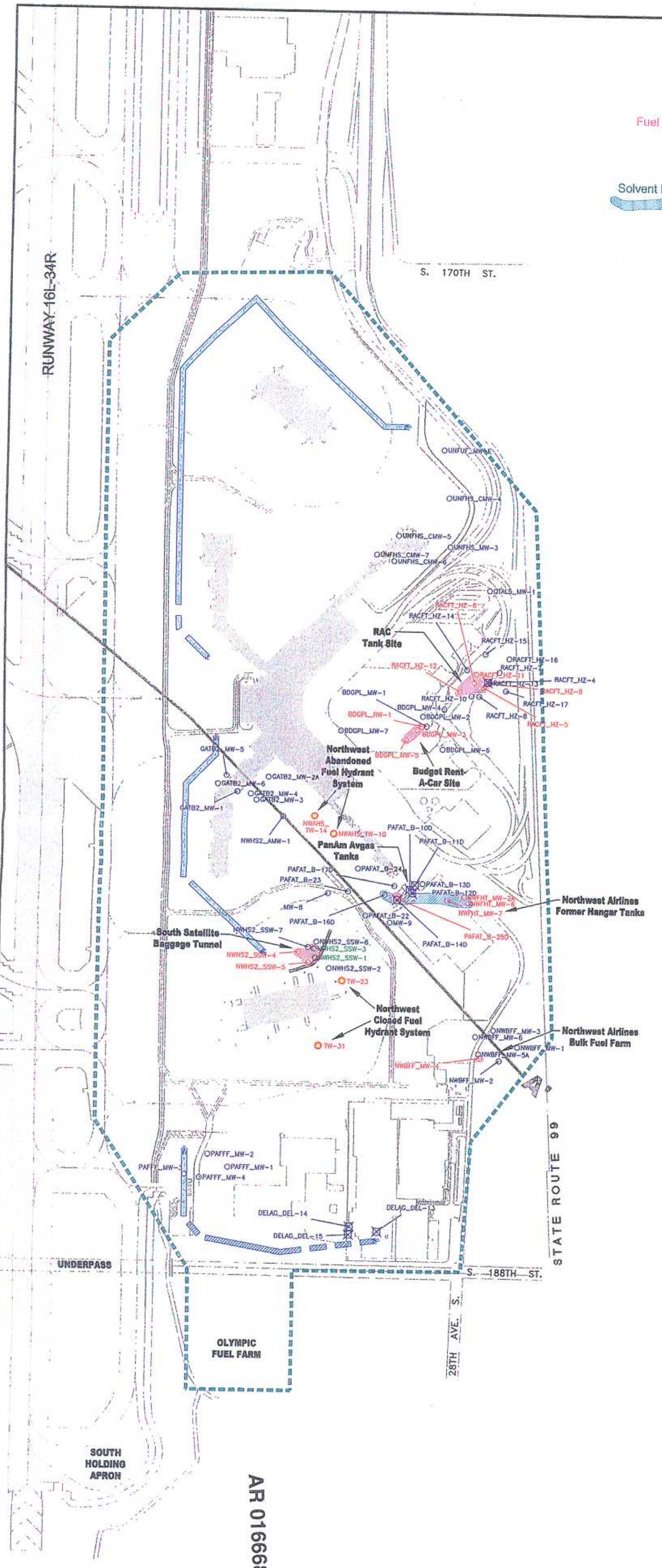
Seattle Tacoma International Airport

Elevation and Depth of Perched Ground Water and Inferred Flow Direction

DATE: 06/14/01

FILENAME: BV99122-GW.dwg

FIGURE NO. 4



Legend

A ——— A' Conceptual Cross Section (see figure 6)

Fuel Impacted — **Extent of MTCA Method A or Method B Cleanup Level exceedance in Qva aquifer.**

Solvent Impacted — *Approximate depth 60 to 100 feet below ground surface.*

Monitoring Wells with Measured Fuel Product
At the most recent monitoring event

Monitoring Wells Exceeding MTCA Standards
At the most recent monitoring event

Monitoring Wells Not Exceeding MTCA Standards
At the most recent monitoring event

Abandoned Monitoring Wells Exceeding MTCA Standards
At the most recent monitoring event

Abandoned Monitoring Wells Not Exceeding MTCA Standards
At the most recent monitoring event

Temporary Well with One Time Ground Water Sample Exceeding MTCA Standards

AOMA Boundary

Maximum Boundary of Impacted Soil
Note: Location of downgradiant AOMA perimeter where soil boring data indicates No MTCA Exceedance at Depth. Boundaries based on environmental investigations of fuel hydrant system lines and fuel pits.

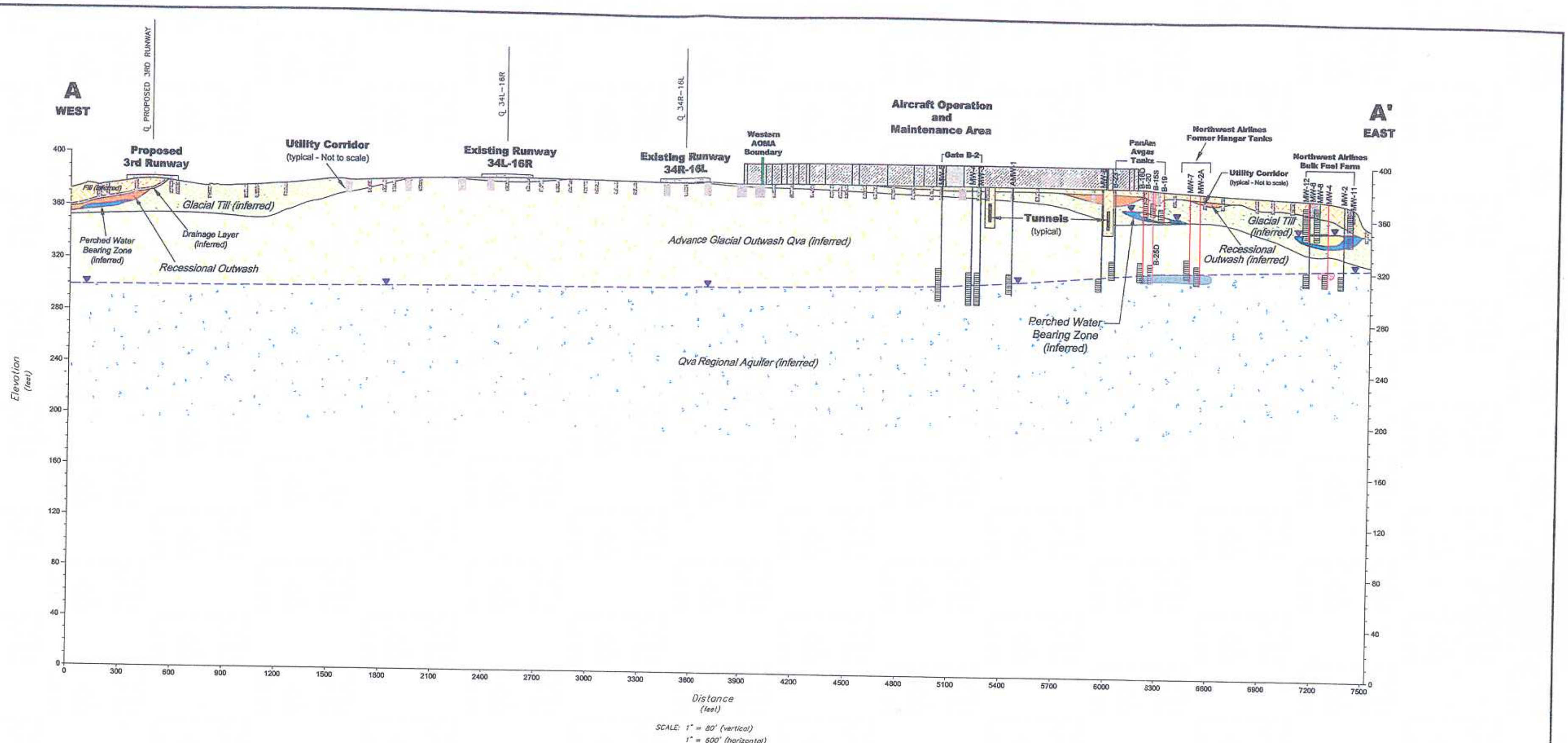
Maximum Boundary of Impacted Soil
Note: Location of downgradiant AOMA perimeter where soil boring data indicates No MTCA Exceedance at Depth. Boundaries based on environmental site investigations.

N

0 300 600 900
Feet
(Scale: 1" = 600')

Seattle Tacoma International Airport
AOMA Wells in Qva Aquifer W/ MTCA Ground Water Standard Exceedances

DATE:	06/21/01
FILENAME:	BV99122-QVA.dwg
FIGURE NO.	5



Legend

Extent of MTCA Method A or Method B Cleanup
Level exceedance in perched water bearing zone.
Perched zones are discontinuous, and appear at various depths from 0 to approximately 40 feet below ground surface.

Fuel Impacted / Solvent Impacted — **Extent of MTCA Method A or Method B Cleanup Level exceedance in Qva aquifer.**
Approximate depth 60 to 100 feet below ground surface.

Ground Water Surface

Monitoring Well with Measured Fuel Product

Monitoring Well Exceeding MTCA Standards

Monitoring Well Not Exceeding MTCA Standards

Well Screen

Note: *Typical depth of 3rd Runway utilities, including water, sewer, IWS lines, electrical and communications ductbanks, etc. are 5 - 10 feet below ground surface, with a maximum depth of 15 feet. Proposed stormwater detention vaults and outlet piping may be located as deep as 40 - 45 feet below ground surface.*

The yellow, aqua and lavender shaded areas represent locations where ground water quality has exceeded MTCA Method A or Method B Cleanup Levels in perched water bearing zones and in the Qva aquifer. These areas are illustrated using the most recent chemical analysis data and may not represent present day conditions. The shaded areas are not compound specific, but were drawn based on an exceedance value for any one of the suite of constituents analyzed.

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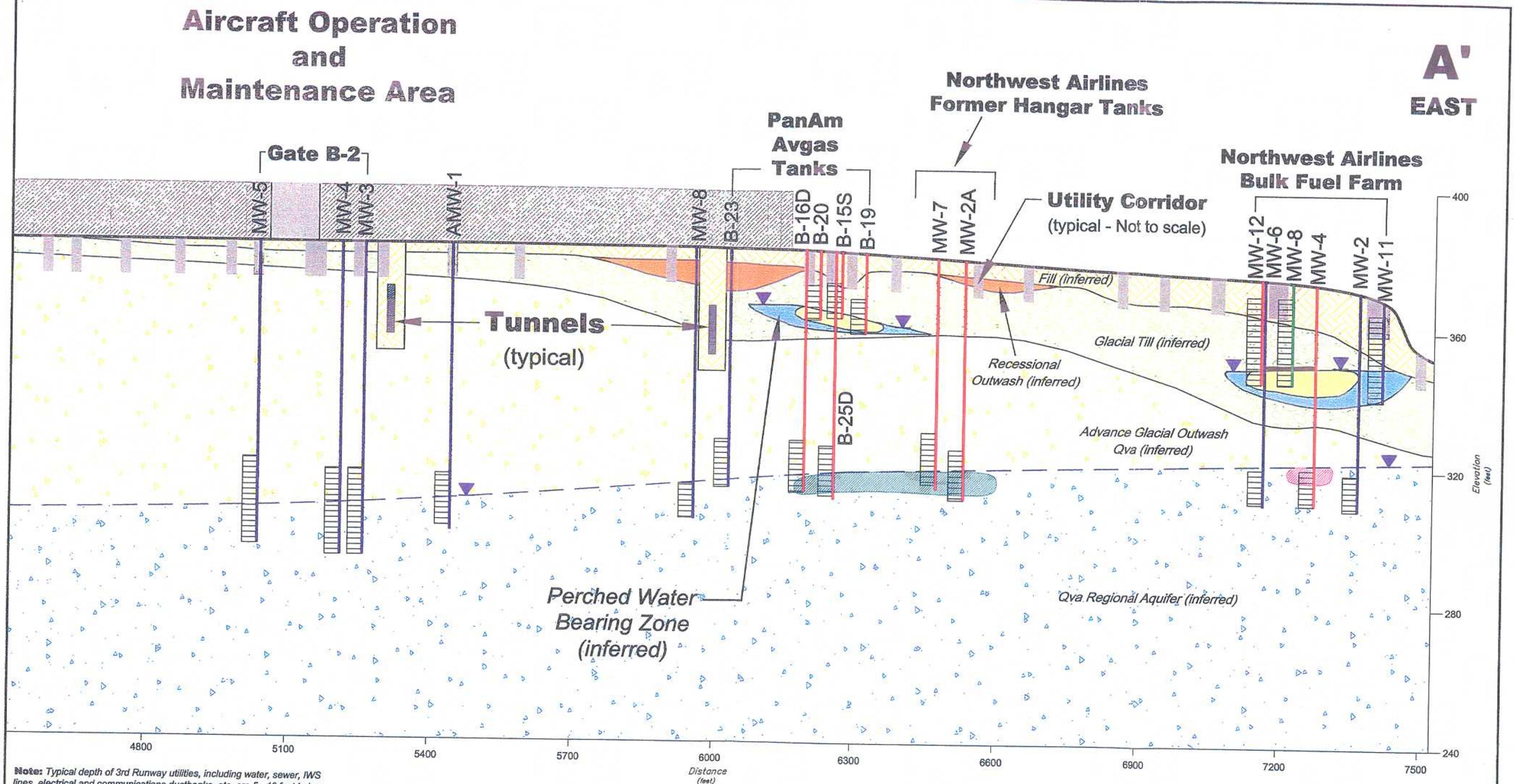
Seattle Tacoma International Airport
Conceptual Cross Section A-A', Showing Underground Utilities and MTCA Ground Water Exceedances

DATE:	06/21/01
FILENAME:	BV99122-SE1.dwg
FIGURE NO.	6



Note: *Typical depth of 3rd Runway utilities, including water, sewer, IWS lines, electrical and communications ductbanks, etc. are 5 - 10 feet below ground surface, with a maximum depth of 15 feet. Proposed stormwater detention vaults and outlet piping may be located as deep as 40 - 45 feet below ground surface.*

The yellow, aqua and lavender shaded areas represent locations where ground water quality has exceeded MTCA Method A or Method B Cleanup Levels in perched water bearing zones and in the Qva aquifer. These areas are illustrated using the most recent chemical analysis data and may not represent present day conditions. The shaded areas are not compound specific, but were drawn based on an exceedance value for any one of the suite of constituents analyzed.

Legend

- **Extent of MTCA Method A or Method B Cleanup Level exceedance in perched water bearing zone.** *Perched zones are discontinuous, and appear at various depths from 0 to approximately 40 feet below ground surface.*
- Fuel Impacted / Solvent Impacted — **Extent of MTCA Method A or Method B Cleanup Level exceedance in Qva aquifer.** *Approximate depth 60 to 100 feet below ground surface.*
- **Ground Water Surface**
- **Monitoring Well with Measured Fuel Product**
- **Monitoring Well Exceeding MTCA Standards**
- **Monitoring Well Not Exceeding MTCA Standards**
- **Well Screen**

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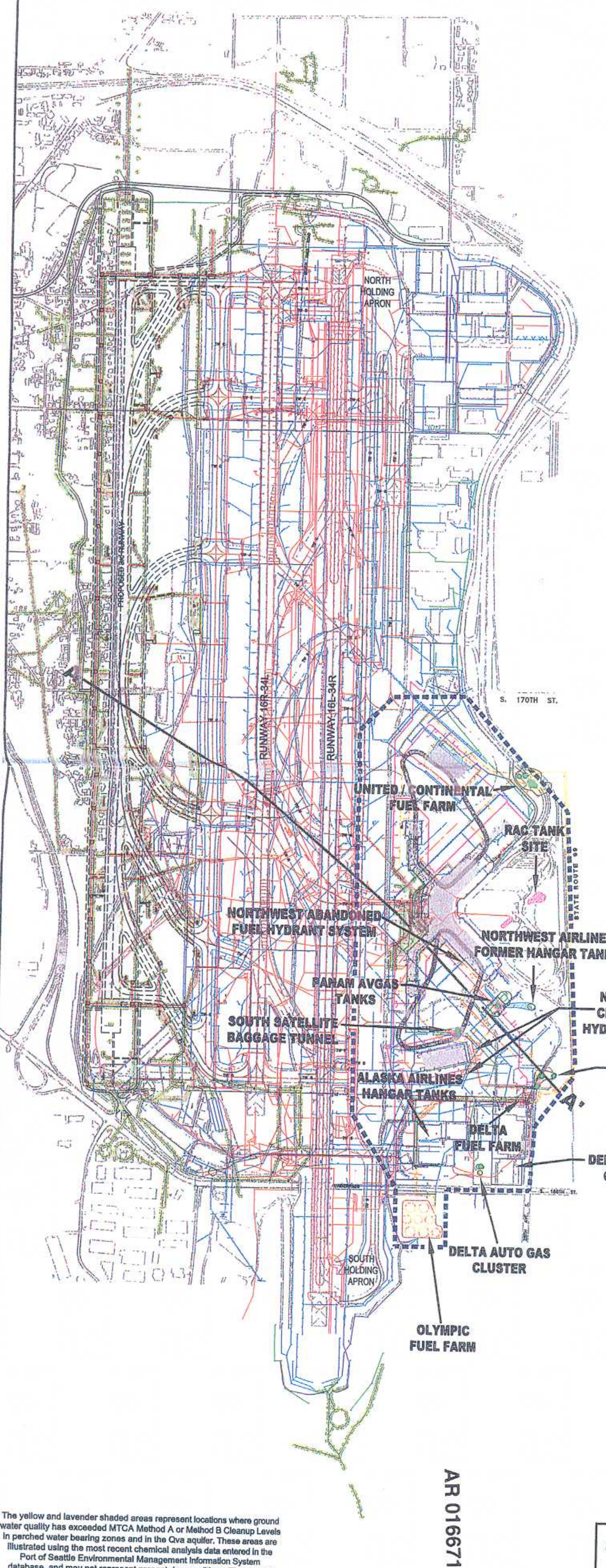
Seattle Tacoma International Airport

Expanded View of Conceptual Cross Section A-A', Showing Monitoring Well Detail

DATE:	06/20/01
FILENAME:	BV99122-SE2.dwg
FIGURE NO.	7



Legend

A ——— A' Conceptual Cross Section
(see figure 6)

Extent of MTCA Method A or Method B Cleanup Level exceedance in perched water bearing zone.
Perched zones are discontinuous, and appear at various depths from 0 to approximately 40 feet below ground surface.

Fuel Impacted
Solvent Impacted
Extent of MTCA Method A or Method B Cleanup Level exceedance in Qva aquifer.
Approximate depth 60 to 100 feet below ground surface.

Monitoring Wells with Measured Fuel Product
At the most recent monitoring event

AOMA Boundary

Underground Utilities

- Existing Fuel Line
- New Fuel Line
- Electric Line
- Industrial Waste System
- Sewer Line
- Storm Drain
- Water Line

STS and Baggage Tunnels

Utilities with a shaded background represent New Utilities Constructed in 2001 (near Main Terminal) and All New Utilities and Electric for the New Runway.

Note: *Typical depth of 3rd Runway utilities, including water, sewer, IWS lines, electrical and communications ductbanks, etc. are 5 - 10 feet below ground surface, with a maximum depth of 15 feet. Proposed stormwater detention vaults and outlet piping may be located as deep as 40 - 45 feet below ground surface.*

N

0 600 1200 1800
Feet
(Scale: 1" = 1200')

The yellow and lavender shaded areas represent locations where ground water quality has exceeded MTCA Method A or Method B Cleanup Levels in perched water bearing zones and in the Qva aquifer. These areas are illustrated using the most recent chemical analysis data entered in the Port of Seattle Environmental Management Information System database, and may not represent present day conditions. The shaded areas are not compound specific, but were drawn based on an exceedance value for any one of the suite of constituents analyzed.

Seattle Tacoma International Airport
Underground Utilities, with MTCA Ground Water Standard Exceedances

DATE: 05/20/01
FILENAME: SV99122-MTCA.dwg
FIGURE NO. 8

Exhibit B

JOHN J. STRUNK
Associate Geologist

Aspect consulting
IN-DEPTH PERSPECTIVE

EDUCATION

B.A., Geology, Coordinate Major in Environmental Studies, 1984, University of Vermont

Continuing Education
40-hour OSHA Health and Safety Trained
Sampling for Hazardous Materials
Hazard Evaluation and Risk Assessment
Introduction to Ground Water Investigations
Ground Water Monitoring at Hazardous Waste Sites
CERCLA RI/FS Workshop
Ground Water Computer Modeling Workshop
Onsite Ground Water and Soil Remediation
Seminar on Characterizing and Remediating DNAPL at Hazardous Waste Sites
Bioremediation Engineering
Transport and Fate of Contaminants in the Subsurface
GSA Field Trip - Pleistocene Geology of Puget Lowland
Visual MODFLOW Shortcourse
Brownfield Redevelopment Seminar

PROFESSIONAL REGISTRATIONS

Registered UST Site Assessor: Washington State Department of Ecology - 1991

PROFESSIONAL ASSOCIATIONS

Association of Ground Water Scientists and Engineers
Northwest Geology Society
Washington Hydrologic Society

EMPLOYMENT

Associated Earth Sciences, Inc. / Bainbridge Island, WA / Associate Geologist / 1995-present
Converse Consultants NW / Seattle, WA / Project Geologist / 1989-1995
State of Vermont, Department of Environmental Conservation / Waterbury, VT / Hydrogeologist / 1985-1989
Wagner, Heindel & Noyes / Burlington, VT / Staff Geologist / 1984-1985

PUBLICATIONS

McCormack, D.H., Strunk, J.J., and Cocks, G.J., April 2000, Stratigraphy of the Des Moines, SeaTac and Burien Areas, South King County, Washington, 2000 Program, The Geological Society of America, 96th Annual Meeting Cordilleran Section, Vancouver, British Columbia, Abstract p. A49.

SUMMARY

Mr. Strunk is an Associate Geologist with over sixteen years of experience in the environmental and ground water industry. His experience in environmental industry includes evaluating hazardous waste sites as required under federal CERCLA and RCRA regulations as well as sites regulated under Washington State Model Toxics Control Act, Dangerous Waste Regulations and Underground Storage Tanks Regulations. His experience includes environmental sampling for hazardous materials, aquifer testing and analysis, geophysical surveys, evaluation of remedial alternatives, data interpretation and technical report writing. Mr. Strunk has conducted hydrogeologic investigations for landfills, hazardous waste contamination studies, water supplies, liquid waste disposal, sludge disposals, and geotechnical studies.

Ground Water Resources
Mr. Strunk has served as a field geologist in supporting the design, installation and testing of water supply wells throughout Washington. His expertise includes well siting studies including geophysical surveys, development of construction documents, on-site geologic logging and construction management, well design, specifying well development techniques, and hydraulic testing and analysis. Washington State Department of Ecology-specified

AR 016673

conditions for several of these projects including monitoring for salt water intrusion, impacts to nearby wells and impacts to adjacent surface water bodies. Mr. Strunk has significant experience in evaluating ground water conditions related to construction. He has served as field geologist on several projects including construction dewatering, evaluation of seasonal ground water inflow into infiltration ponds, and evaluation of impacts of hillslope dewatering on ground water gradients using numerical ground water flow models. He has performed aquifer analyses and designed dewatering systems for several sewer line construction dewatering projects. In addition, he has evaluated the effects of construction dewatering on contaminant migration at nearby hazardous waste sites and developed alternatives to reduce the impact of dewatering.

Landfills
Mr. Strunk is an Associate Geologist with significant experience in environmental monitoring at landfills throughout Washington and Vermont. Mr. Strunk has served as field operations coordinator and project manager for design and implementation of ground water, surface water, and gas monitoring at multiple landfill facilities. He has provided ground water monitoring systems for landfills in San Juan, Snohomish, King counties. He has been involved in the design and construction of a ground water and gas detection monitoring system at the Houghton Custodial Landfill in King County. In the last five years, Mr. Strunk has been involved with landfill site characterization investigations at the Duvall, Cedar Falls, South Park, Enumclaw and Cedar Hills landfill facilities for King County. Currently, Mr. Strunk is the project manager for the South Park Custodial Landfill and manages a multi-disciplinary team in evaluating the environmental, geotechnical and redevelopment issues related to the landfill. Mr. Strunk has assisted in the development of a work plan designed to characterize the hydrogeologic conditions for permitting Area 6 of the Cedar Hills Landfill.

PROFESSIONAL EXPERIENCE

HYDROGEOLOGIC PROJECTS

AREA-WIDE GROUND WATER STUDY
SEATTLE-TACOMA INTERNATIONAL AIRPORT
SeaTac, Washington
Project manager for an ongoing ground water study at the Seattle-Tacoma International Airport for the Port of Seattle. The ground water study is being conducted under a MTCA Agreed Order between Ecology and the Port of Seattle. The purpose of the study is to gain a more complete understanding of the direction and behavior of ground water flows beneath the airport and to evaluate that contamination that exists beneath portions of the airport is not a threat to drinking water supply wells or surface water bodies in the area. The study will be conducted in two phases. The first phase includes the development of a comprehensive database that catalogs environmental data collected at the airport and ground water wells located on airport property and in the USGS Des Moines Quadrangle. Select wells on the airport property will be included as part of a site-wide ground water monitoring network. A computer model of ground water and contaminant transport flow throughout the study area will be developed. The computer modeling will help to identify the potential risk of contaminants in ground water reaching public and private drinking water supply wells and nearby surface water bodies including: Bow Lake, Des Moines Creek and Miller Creek. The second phase of the study will include drilling additional ground water monitoring wells that could be used to verify Phase I study results and to perform additional ground water monitoring. Information from the study may be used by the parties conducting cleanups at the airport and could provide a basis for consistent approach to cleanup actions within the airport.

THIRD RUNWAY PROJECT SUPPORT
Seattle-Tacoma International Airport
SeaTac, Washington
Project manager for providing technical support to Third Runway project team regarding ground water and contaminant transport issues. Provided technical data compiled for ground water studies to numerous consults involved in the design of the Third Runway embankment. Provide technical review regarding the development of ground water monitoring plans associated with embankment monitoring. Developed an initial evaluation regarding

the preferential pathways of contaminant migration via subsurface utility lines in regards to the Third Runway construction area.

INDUSTRIAL WASTE SYSTEM HYDROGEOLOGIC STUDY
Seattle-Tacoma International Airport
SeaTac, Washington
Project manager for a hydrogeologic study at the Port of Seattle's Industrial Waste System (IWS) facility and treatment lagoons. The purpose of the study is to evaluate if historic and current wastewater management practices have the potential to impact ground water resources in the immediate area. The study will conform to Washington Department of Ecology's Ground Water Quality Standards. Historic monitoring data on the treatment processes, soil, sediment, and ground water monitoring data were reviewed. A ground water monitoring network of wells was installed in the regional aquifer at Lagoons 1 and 2. Perched ground water wells were completed at Lagoon 3. AESI has coordinated with engineering activities associated with Lagoon 3 expansion throughout the design process. A long-term ground water monitoring program was implemented in May 1999. Background water quality was statistically evaluated for potential impacts to the ground water resource from the IWS facility infrastructure and lagoons.

CONCOURSE D GROUND WATER REMEDIAL INVESTIGATION/FEASIBILITY STUDY
Seattle-Tacoma International Airport
SeaTac, Washington
Developed work plan for the execution of field activities to define the nature and extent of ground water contamination resulting from waste management practices associated with aircraft maintenance facilities. The RI was performed in accordance with the Washington State Department of Ecology Model Toxics Act (MTCA) and with federal CERCLA legislation. Five ground water monitoring wells have been installed in areas where elevated levels of soil contamination were detected during focused soil RI. Quarterly ground water monitoring events were conducted for a one-year period. Sampling efforts did not indicate an impact to the glacial outwash aquifer. A deep monitoring well installed at the site has shown that the shallow and intermediate regional aquifers appear to be interconnected. Soil samples collected from the monitoring well borings were field screened using flame ionization detection and compound specific detector tubes. Samples exhibiting elevated responses were submitted for chemical analysis. A "no further action" status was issued by Ecology.

PORT OF SEATTLE SOUTHWEST HARBOR PROJECT - REMEDIATION AREA 4 (PACIFIC SOUND RESOURCES)
Seattle, Washington
Participated on project that redeveloped the Pacific Sound Resources (Wyckoff) site in Elliott Bay, Seattle, Washington, as part of the Port of Seattle Southwest Harbor Project. The project included remediation investigations, feasibility study, cleanup action plan, and design plans and specifications for cleanup activities. Affected media include soil, ground water, and sediment contaminated with creosote, pentachlorophenol (PCP), polynuclear aromatic hydrocarbons (PAHs), and metals including arsenic, chromium, copper, and zinc. Role on the project includes remedial investigations for ground water and sediment. Ground water investigations include dissolved phase contaminants, sinking product (creosote and PCP) thickness, floating product (carrier solvents) thickness, and bail down tests and water level measurements over tidal cycles. Sediment investigations focus on offshore areas in Elliott Bay and include both surface sediment and sediment core sampling. Mr. Strunk was responsible for the feasibility study elements related to ground water including treatability testing for ground water treatment, ground water modeling for ground water migration, fate, and extraction analysis, and evaluation of recovery systems for floating and sinking product through both interim actions and long-term recovery.

PORT OF SEATTLE ON-CALL TECHNICAL SERVICES
Seattle, Washington
Provide various environmental and database/GIS management to the Port of Seattle on an on-call basis. Work has included the refinement of the Port's field sampling data acquisition system, ground water sampling at marine terminal sites, database design and well logging software evaluation.

BLUE MOUNTAIN GOLF COURSE
Perry, Oregon
Performed preliminary evaluation of the ground water conditions at the proposed Blue Mountain Golf Course site in Perry, Oregon. The purposes of this evaluation was to provide a hydrogeologic framework and establish existing ground water conditions at the site, and evaluate potential ground water impacts and mitigating measures. Union County Planning Department required information that would mitigate potential domestic well contamination resulting from site development. A door-to-door survey of residents in lower Perry was conducted to gather information regarding drinking water wells. Where permission was granted and the well was readily accessible, a ground water level measurement was obtained. Subsurface and ground water conditions at the site were explored in a series of eight test pits using a backhoe. A visual reconnaissance of the site and surrounding area was performed. In addition, available geologic and ground water reports and maps were reviewed for the project area.

MUNICIPAL WELL GROUND WATER RESOURCE INVESTIGATION
Yakima, Washington
Collected and interpreted hydrogeologic data for a proposed 3000-gpm municipal well for the City of Yakima. Specifically addressed the water-bearing potential of the basalt aquifer in a structurally complex area. Compiled and interpreted water quality data to assess potential water quality problems at the proposed location. Interacted with Washington State Department of Ecology, drillers, and neighboring water districts to determine final well location. Recommended well location was drilled and completed at 1100 feet. Performed 24-hour pump test at a pumping rate of 2500 gpm. Designed and implemented automatic data acquisition system to gather water level data at pumping well and an observation that was under 35 psi of shut-in pressure.

PRESTON INDUSTRIAL PARK ENVIRONMENTAL IMPACT STATEMENT
Preston, Washington
Evaluated existing ground water conditions, impacts, and mitigating measures for a proposed 129-acre industrial park in eastern King County. Analysis included potential ground water depletion impacts on an adjacent wetland, on-site septic system impact on ground water quality, and development of alternative well locations and pumping schemes to mitigate wetland impact. Acted as task leader for stream gauging and ground water sampling.

TAMOSHAN SUBDIVISION WELL
Thurston County, Washington
Managed construction of a water supply well for a subdivision in Thurston County. Responsibilities included logging samples, determination of completion zone, and well screen design. Performed periodic water quality analyses during drilling to ensure completion zone was low in iron and magnesium. Designed, monitored and analyzed step drawdown test and 24-hour pump test in tidally influenced aquifer. Monitored water quality parameters in nearby wells to evaluate potential of saltwater intrusion.

ENVIRONMENTAL PROJECTS

CONCOURSE A EXPANSION PROJECT, ENVIRONMENTAL SERVICES, PROJECT COORDINATION
Seattle-Tacoma International Airport
SeaTac, Washington
AESI is providing project support to the Floyd & Snider, Inc. project team on the Concourse A Expansion Project. AESI has provided the project team with database queries of relevant historic environmental data in the Concourse A area to be used for risk based unsaturated contaminant transport modeling. Subsurface geologic interpretations were also developed through the project area to gain an understanding on the glacial stratigraphy underlying the site and its relationship to contaminated soil distribution. AESI project team members are also interfacing with the Concourse A project team regarding the use of the unsaturated soil modeling methods and results for integration into the ground water fate and transport modeling being performed as part of the airport wide ground water study.

AIRCRAFT FUEL SYSTEM STUDY
Seattle-Tacoma International Airport
SeaTac, Washington
AESI key personnel member of a relatively large and diverse project team responsible for evaluating existing fuel supply and delivery operations at Seattle-Tacoma International Airport on behalf of the Port of Seattle and various

airline companies. Reviewed and compiled existing subsurface contamination information within the aircraft fuel facilities and operational areas to develop an approach for addressing soil and ground water contamination which could be encountered during construction of additional fuel delivery systems.

CONCOURSE D CONTAMINATED SOIL REMOVAL PROJECT
Seattle-Tacoma International Airport
SeaTac, Washington
Field manager for compliance monitoring and sampling for the excavation of approximately 35,000 cubic yards of contaminated soil from an airport expansion project site.
Petroleum hydrocarbons and chlorinated industrial solvents were detected during demolition of a commercial airline hanger. The Port elected to perform an independent interim remedial action to clean up the contaminated soil under the State of Washington's Model Toxics Control Act cleanup regulations. The remedial action selected was excavation with performance and confirmation monitoring to document that the cleanup action had attained the established cleanup standards. Soil samples were collected from deep excavations (>20 feet in depth) and field screened throughout the excavation process. A northing and easting field coordinate system was established at the site that enabled field staff to accurately locate and track where samples were collected. The sample tracking system proved very effective in providing direction to the contractor of areas of the site requiring over excavation. Flame ionization detectors and compound specific detector tubes were used to monitor the excavation. Over 300 soil samples were collected for chemical analysis by on-site and off-site laboratory facilities. Ambient air conditions were also monitored for worker health and safety. Submitted approximately 30 samples per day to on-site laboratory for 24-hour turnaround of target chlorinated volatile organic compounds and total petroleum hydrocarbons. The on-site laboratory data proved instrumental in monitoring the performance of the excavation activities and providing direction to the excavation contractor.

PROPOSED JUNIOR HIGH SCHOOL No. 6 TANK REMOVAL
Kent, Washington
Two underground storage tanks were decommissioned by removal. A release of diesel fuel oil was confirmed from the area of the former diesel tank. The diesel tank excavation encountered ground water at approximately 14 feet below ground surface and petroleum product was observed floating on the ground water surface. Confirmation sampling in the vicinity of the gasoline tank indicated that no release of petroleum resulted from the gasoline tank. Surficial soil contaminated with petroleum products and low-level chlorinated solvents was also excavated from the site. Approximately 3,075 cubic yards of petroleum-contaminated soil was processed and treated on-site by a mobile thermal processor. Established a survey grid system to track samples collected within the excavation. This system proved very effective in directing the contractor where soil removal should occur based on field screening and laboratory analysis. Excavated material was screened prior to treatment to remove oversized cobble size material. Ground water samples collected from an existing on-site monitoring well and from ground water pooled in the bottom of the diesel tank excavation contained levels of total petroleum hydrocarbons above the Washington State Department of Ecology cleanup level. Recommendations were made to investigate the extent of ground water contamination at the site.

POINT WELLS FUEL DISTRIBUTION CENTER
Richmond Beach, Washington
AESI provided soil and ground water remedial services at the Chevron Point Wells fuel storage and distribution center (110-acre site) located at Richmond Beach on Puget Sound. The facility has been in operation since 1914 and has above ground refined petroleum product storage capabilities of approximately 700,000 barrels. Installed, monitored and maintained over 80 ground water monitoring wells at the facility as part of soil and ground water characterization, and subsurface liquid hydrocarbon recovery operations. Designed, installed, and operated large-scale interim liquid hydrocarbon recovery systems in two areas of the facility. Prepared an interim remedial action plan to implement liquid hydrocarbon recovery at three additional areas including the adjacent asphalt plant. Extensive modeling using FLOWPATH was performed to evaluate capture zones. Prior to development of the interim remedial action plan, a 72-hour tidal study was performed to determine the effect of tidally-induced ground water level changes on liquid hydrocarbon thickness and to determine the net ground water flow direction. Results of the tidal investigation were used for siting additional liquid hydrocarbon recovery wells and specifying timer cycles for skimmer pumps.

EMBASSY SUITES HOTEL SITE/GAS STATION DEMOLITION
Bellevue, Washington
In response to Phase II recommendations, documents were prepared by the previous gas station owner's consultant. Then reviewed the environmental work covered in documents. The site consisted of underground storage tanks, sump, and a pesticide wash area. Specific recommendations were made for removal of underground storage tanks, storm drain and sump demolition and cleanup of pesticide residues prior to the purchase of the property.

PACIFIC NORTHERN OIL - PIER 91
Petroleum Contamination Site Assessment
Seattle, Washington
Involved a phased hydrogeologic assessment to determine the extent of contamination resulting from a release of diesel fuel. A preliminary hydrogeologic assessment was the first phase of this assessment followed by a Phase I remedial investigation. Ground water levels have been monitored utilizing a datalogger for a 24-hour cycle to determine how ground water gradients are affected by tidal fluctuations. A free-product recovery test was performed on an existing monitoring well to determine the true thickness of diesel fuel floating on the water table. Four existing wells have been sampled for total petroleum hydrocarbons. The Phase I remedial investigation will consist of installing four new monitoring wells based on results obtained during the preliminary hydrogeologic assessment. Based on the results of this phase, recommendations will be made for continuing remedial investigation and/or remedial action.

LARRY'S ARCO
Everett, Washington
Performed a subsurface investigation at a former Arco station for the Washington Department of Ecology to assess the extent and degree of hydrocarbon contamination resulting from a release in an underground storage tank (UST) system. Initial work included the development of a site work plan, which contained a sample and analysis plan, quality assurance project plan, and a health and safety plan. Prepared technical specifications for drilling and laboratory subcontractors. Ten soil borings were completed by hollow-stem drilling methods through dense glacial deposits consisting of glacial till overlying advance glacial outwash sand and gravel. Borings were located in areas surrounding the UST and service islands. Seven borings were advanced to a depth of 40 feet below ground surface (bgs) and three borings were drilled to 80 feet bgs. Soil samples were collected by split-spoon samples lined with brass sleeves. Field screening was performed by head space methods using a photoionization instrument. Three soil gas recovery wells were installed in zones exhibiting elevated levels of hydrocarbons based on field screening results. Results of the investigation indicated that hydrocarbon levels were limited to areas surrounding the UST system and soil gas vapors were elevated beneath a silt horizon that acted as a stratigraphic barrier for vapor migration.

SEAFIRST BANK RAINIER AVENUE SITE
Seattle, Washington
Level II site assessment of a used car lot. Project consisted of identifying fuel and solvent contamination in soil, ground water, and drains. Developed sampling plan, managed installation of monitoring wells, soil and ground water sampling and drain sediment sampling. Developed remedial action plan and coordinated subcontractors and confirmation sampling.

ABANDONED FIRE STATION
Auburn, Washington
Remedial investigation for a leaking underground fuel tank. Managed monitoring well installation and ground water sampling. Interfaced with the Department of Ecology to gain approval for location of monitoring wells. Site listed as a confirmed contaminated site on the Department of Ecology's SMIS data base.

OLYMPIC AUTO WRECKING CONTAMINATED SOIL REMEDIATION
Everett, Washington
Conducted an environmental investigation to determine the extent of petroleum hydrocarbon and lead soil contamination resulting from an automobile wrecking yard. The initial phases of the project involved the completion of test pits and shallow soil borings to determine the areal extent of contamination and develop volumetric estimates of soil elevated above MTCA cleanup levels. Approximately 7 cubic yards of lead-contaminated soil was characterized as dangerous waste using TCLP testing procedures. The lead soils were containerized, manifested and transported to a certified hazardous waste disposal facility located in Arlington, Oregon. Soil contaminated with petroleum hydrocarbons was excavated and stockpiled on-site. Soil samples were collected in excavations ranging in depth from about 5 to 15 feet. Stockpiled soil was screened to remove oversized rubble and wood debris prior to placement into on-site bioremediation treatment cells. Approximately 400 CY of soil was processed and placed in the treatment cells. Nutrient additives and microbe inoculation were made to the treatment cell. The treatment cell was monitored for nutrient levels and moisture content on a weekly basis and nutrients and water were applied as needed to maintain optimum conditions for microbe activity. The treatment cell was also tilled periodically to promote oxygenated conditions. Monthly soil samples were collected and submitted for analytical testing to monitor the progress of the bioremediation. Total petroleum hydrocarbon contamination below MTCA levels were achieved within a 3-month time period. The treated soil was designated as a Class 2 soil and was recommended to be used as fill during on-site construction.

ELLIOTT BAY OFFICE PARK
REMEDIAL INVESTIGATION AND SITE REMEDIATION
Seattle, Washington
Level I and II site assessments indicated levels of hydrocarbons above Ecology's MTCA Method A Cleanup levels in soil and ground water affected this former service station. In response to these findings, a RI/FS was conducted to determine the extent and volume of soil and ground water contamination. Contracted with Laucks Testing Laboratories to provide on-site analytical services during the soil boring investigation. Preliminary cost estimates for alternative remedial technologies were calculated as part of a feasibility screening study. Remediation by soil vapor extraction was determined to be the best remedial alternative available. Designed, permitted, and installed the vapor extraction system that consisted of dual soil venting ground water monitoring wells, dedicated vertical soil venting wells, and horizontally screened soil venting pipes. Performed monthly hydrocarbon removal calculations from each venting port to evaluate performance and to verify compliance with Puget Sound Air Pollution Control Agency (PSAPCA) permitted emission levels. The system was adjusted in the field to allow maximum removal of hydrocarbons without exceeding permitted levels.

SUBSURFACE INVESTIGATION SUMMARY
Everett, Washington
Project manager for the contract with The Boeing Company to perform subsurface investigations at six potential solid waste management units located at the Boeing Commercial Airplane Group, Everett facility. Two of the SWMUs were former fire training pits, three SWMUs were former underground storage tank locations, and one site is adjacent to aboveground distillation tanks. The purpose of the investigation is to evaluate potential impacts to soil and, if appropriate, ground water, resulting from former waste management practices. Twenty-three soil borings were completed to a depth of 15 feet and 60 soil samples were submitted to laboratory analysis of select volatile

organic compounds, semivolatile organic compounds, metals, total petroleum hydrocarbons and tributyl phosphate. Ground water was encountered at three of the SWMUs and one-time samples were collected for laboratory analysis.

BOEING EVERETT FACILITY - BUILDING 40-56
Everett, Washington
Project involved removal of two underground storage tanks (USTs) located north of Building 40-56 at the Boeing Everett facility. At the time of the excavation, petroleum odors and staining were detected in the sandy backfill surrounding the tanks. Laboratory testing confirmed the presence of total petroleum hydrocarbons (TPH) above the Washington State Department of Ecology, Model Toxics Control Act (MTCA) standards in the south sidewall adjacent to the diesel tank and in the excavation stockpiles. Re-excavation of the south sidewall occurred and resampling from this area indicated levels of TPH below the MTCA standards. Also included confirmation soil sampling data from an area located southeast of the UST excavation.

THE BOEING COMPANY
BOEING COMMERCIAL AIRPLANE GROUP EVERETT DIVISION
FLIGHTLINE STALL 112 DIESEL UST
Everett, Washington
Contracted by Boeing to perform a subsurface investigation to determine the extent of hydrocarbon impacted soil resulting from a release of diesel fuel form an underground storage tank UST. Soil borings were completed and soil samples and one-time ground water samples were collected as part of the investigation. The borings completed during this investigation were used to supplement existing data in an effort to characterize the extent of hydrocarbon-impacted soil and to aid in estimating the quantity of soil which would be require removal during UST closure. A UST closure by removal was conducted which conformed to the Ecology UST site assessment guidelines. Confirmation soil samples were collected from the excavation sidewalls and bottom. Soil samples from the excavation bottom were collected from about a depth of 12 feet. An estimated 80 cubic yards of soil were removed and stockpiled at the Everett facility. Soil samples collected from the stockpile indicated levels of petroleum hydrocarbons above MTCA cleanup levels. Boeing arranged for the disposal of the stockpile.

THE BOEING COMPANY
BOEING COMMERCIAL AIRPLANE GROUP EVERETT DIVISION
UNDERGROUND STORAGE TANKS EV-48 AND EV-49
Everett, Washington
Project involved removal of two underground storage tanks (USTs), EV-48 (10,000 gallon) and EV-49 (5,000), located north of Building 40-56 at the Boeing Everett facility. At the time of the excavation, petroleum odors and staining were detected in the sandy backfill surrounding the tanks. Laboratory testing confirmed the presence of total petroleum hydrocarbons (TPH) above the Washington State Department of Ecology, Model Toxics Control Act (MTCA) standards in the south sidewall adjacent to the diesel tank and in the excavation stockpiles. Reexcavation of the south sidewall occurred and resampling from this area indicated levels of TPH below the MTCA standards. Also included confirmation soil sampling data collected from an area located southeast of the UST excavation.

THE BOEING COMPANY
BOEING COMMERCIAL AIRPLANE GROUP EVERETT DIVISION
SOUTH FUELING STALL EQUIPMENT
Everett, Washington
Phased investigation to determine the extent of jet fuel contamination resulting from the release of product from an overflow containment tank (OCT EV-110-1). An interim remedial action was conducted to remove approximately 10 cubic yards of petroleum contaminated soil in order that an utility construction could proceed on schedule. A soil gas survey and geophysical survey was conducted to estimate the extent of the contamination and map out buried utility lines which may be acting as preferential pathways for contaminant migration. Soil borings and ground water monitoring wells were installed to confirm the petroleum hydrocarbon distribution.

THE BOEING COMPANY
BOEING COMMERCIAL AIRPLANE GROUP EVERETT DIVISION
SOUTH FIRE TRAINING PIT
Everett, Washington

Completed an investigation to investigation to identify the impact of the use of a fire training pit at the Everett Division facility. Twelve soil borings were completed in the area of the fire training pit and related oil/water separator to evaluate potential impact to soil. It is estimated that approximately 55 cubic yards of soil contains petroleum hydrocarbons above the MTCA cleanup level.

STRATTEN MOUNTAIN SKI RESORT
Winhall, Vermont
Investigated a number of upland sites to dispose of 300,000 gpd of wastewater effluent. Study involved establishing and monitoring surface water stream gauging stations, ground water monitoring well installation and monitoring, and testing of simulated spray irrigation system model to determine aquifer response.

MOUNT ASCUTNEY SKI RESORT
Brownsville, Vermont
Performed site evaluations for disposal of 125,000 gpd of wastewater effluent by subsurface high rate system and spray irrigation. Installed stream gauging stations to develop rating curves for receiving surface water. Performed large-scale aquifer testing to calculate loading rates.

BARRE COAL TAR SITE
Barre, Vermont
Performed a hydrogeologic investigation to determine the nature and extent of contamination associated with an abandoned coal gasification plant. The investigation included the installation of ground water monitoring wells to locate and measure the location of a dense non-aqueous phase liquid (DNAPL). The site was located adjacent to the Winooski River and the DNAPL was found to be migrating off-site and seeping through the river bottom. Remedial measures such as hydraulic control and physical containment systems were evaluated to control the seepage of the DNAPL into the river.

LANDFILL PROJECTS

SOUTH PARK CUSTODIAL LANDFILL
Seattle, Washington
Mr. Strunk is project manager for hydrogeologic, engineering, industrial development assessment and public involvement services related to the South Park Custodial Landfill. The landfill is a brownfield site located within the Duwamish River corridor. The first phase of the project consisted of reviewing available information for the purpose of evaluating environmental conditions at the site and surrounding area, evaluating the development potential of the site, and making recommendations on how to proceed to complete an understanding of the site with respect to environmental conditions and development potential. Environmental characterization of the landfill was conducted to evaluate ground water, surface water, and gas migration. Additional work consisted of the completion of soil borings and monitoring wells, installation of gas probes, evaluation of the soil and waste fill conditions from a both an environmental and geotechnical standpoint, and risk-based decision-making for development of alternative cleanup standards. Conducted environmental monitoring of ground water field parameters, ground water sampling, aquifer testing and hydrogeologic interpretation. Seasonal ground water potentiometric maps were constructed and ground water flow velocities were calculated for the alluvial aquifer. Week-long ground water monitoring was conducted using pressure transducers and datalogger system to evaluate the potential for tidally induced ground water level changes from the Duwamish River.

Data Gap Evaluation
Compiled and reviewed existing data at the site including aerial photograph review from 1936 through 1997, compilation of ground water well, gas and surface water data. Reviewed a number of off-site geotechnical investigation reports, which provided information on subsurface soil conditions from a construction standpoint.

Cover Soil Evaluation
Completed over 60 shallow test pits and completed soil laboratory testing to evaluate shallow soil contamination. Identified fuel component hydrocarbon contamination and calculated risk-based TPH cleanup standards for the impacted soils. Recommended hot spot removals and site capping as potential remedial alternatives.

Geotechnical Evaluation
Supervised geotechnical evaluation based on historic site data and new data generated to evaluate liquefaction conditions, feasibility of building foundation design, review of piles systems and settlement issues.

Surface Water / Wetland Evaluation
A limited surface water evaluation was conducted to gain a better understanding of existing storm water runoff from the site and evaluate some engineering controls. Preliminary alternatives including a wet pond and underground retention systems were evaluated. A wetland assessment was performed and no regulated wetlands were identified at the site.

Ground Water and Gas Monitoring
Established a ground water and landfill gas monitoring system around the perimeter of the 41-acre site. Ground water samples are collected on a quarterly basis using dedicated sampling equipment. Gas monitoring has been conducted on a monthly basis. Hydrogeologic services included monitoring well design, well development, aquifer testing and ground water flow condition evaluation. Ground-water-to-surface-water pathway analysis is currently being evaluated.

Public Participation
Coordinated facilitation support to King County Solid Waste Division in a public involvement program. The team has developed consensus among an active Citizens Advisory Committee regarding issues affecting site redevelopment.

ENUMCLAW LANDFILL
Enumclaw, Washington
Mr. Strunk is serving as project manager for improvements to the Enumclaw Landfill ground water and gas monitoring network. Gas probes and ground water monitoring wells located on private property were evaluated for abandonment. New gas probes and wells were designed along the western landfill property boundary. Well development of the replacement wells was performed. A pneumatic slug test method was designed to estimate the hydraulic characteristics of a very permeable sand and gravel aquifer. Ground water potentiometric surface maps were produced and an updated ground water velocity was calculated. Mr. Strunk provided negotiation support to King County Solid Waste Division for well construction approval and gas probe variance. AESI prepared a report for review and approval by Washington State Department of Ecology Solid Waste and Seattle-King County Department of Public Health representatives.

DUVALL CUSTODIAL LANDFILL
King County, Washington
Mr. Strunk provided project support for a landfill investigation that included evaluation and corrective action for the ground water monitoring system, leachate collection system, cover, site drainage, and landfill gas conditions. Existing hydrogeologic, landfill gas, climatic, water quality and landfill closure engineering data was compiled and reviewed. Regional hydrogeologic data were incorporated with site-specific data to develop a conceptual model of the geologic/hydrogeologic framework at the landfill and surrounding vicinity. Low-flow sample and purge methods were utilized to prove the presence of false metal detections at the site that exceeded MCLs. Landfill gas chemistry was evaluated in conjunction with ground water chemistry to assess gas/ground water transfer of contaminants. An evaluation of the current ground water monitoring well system was made based on the position of the well in the hydrogeologic system, historic water quality data and construction details. Previous well construction methods caused the need for replacement of selected wells. Additional wells were installed to complete a comprehensive ground water monitoring system in three aquifer systems beneath the site. A gas monitoring network is currently being installed.

CEDAR FALLS LANDFILL
King County, Washington
Mr. Strunk assisted in performed a landfill investigation that included evaluation of the ground water monitoring system, site drainage, landfill cover and gas collection system. Existing hydrogeologic, landfill gas, climatic, water quality and landfill closure engineering data was compiled and reviewed. Regional hydrogeologic data was incorporated with site-specific data to develop a conceptual model of the geologic/hydrogeologic framework at the

landfill and surrounding vicinity. An evaluation of the current ground water monitoring well system was made based on the position of the well in the hydrogeologic system, historic water quality data, construction details, and results of the well redevelopment. Surface water data, rainfall and cover installation were reviewed to evaluate the effectiveness of the cover material. A water balance was developed that was used in the evaluation of the cap effectiveness, volume of leachate generation and recharge/ discharge characteristics of the aquifer system. Evaluation of water quality data showed the geomembrane cover to be very effective in reducing contaminant levels in ground water. Recommendations were provided for improvements to the ground water monitoring system.

CEDAR HILLS LANDFILL
King County, Washington
Mr. Strunk assisted in the preparation of a work plan designed to characterize the hydrogeologic conditions per Washington Administrative Code (WAC) 173-351 for permitting Area 6 of the Cedar Hills Landfill. Attended negotiations with Washington State Department of Ecology and King County Solid Waste regarding the design of the hydrogeologic investigation. Identified perched ground water bearing target zones and recommended sonic drilling methods to collect continuous soil cores to classify the thickness and extent of perched water bearing units.

ALKI TRANSFER/CSO PROJECT
West Seattle Pump Station
Slurry Trench Design and Ground Water Modeling
Seattle, Washington
A steady-state two-dimensional horizontal aquifer simulation model, FLOWPATH, and three-dimensional model, MODFLOW, were used to aid in the design and configuration of a slurry trench at the proposed West Seattle Pump Station as part of the Alki Transfer/CSO project. A drainfield was to be installed on the west side of the pump station to lower the ground water surface and stabilize a landslide mass located in the vicinity of the pump station. Preliminary analyses indicated that the lowering of the ground water around the drain field would cause a reversal of the regional ground water flow direction. Ground water flow from a portion of the former West Seattle Landfill would be directed toward the pump station and finally to the drain field. Concern was raised that the reverse flow may cause migration of the contaminants from the landfill to the drain field. A slurry trench was proposed to be installed between the drain field and Harbor Avenue SW to reduce the ground water flow gradient and to prevent the potential migration of the contaminants toward the pump station. The purpose of the ground water modeling task was to delineate the capture zone for the drain field and to determine the length and configuration of the slurry trench required to cut off the ground water flow reversal. Worked closely with hydrologists and engineers in the design of the slurry wall.

HOUGHTON CUSTODIAL LANDFILL
Kirkland, Washington
Mr. Strunk was the field operations hydrogeologist for ground water studies at the Houghton Custodial Landfill. The project involved ground water/gas investigation at a 40-acre closed landfill in Kirkland, Washington. Designed and implemented an eleven-monitoring-well network in two aquifers including two off-site residential wells. Identified contaminants including chlorinated solvents and conventional leachate constituents. Mr. Strunk was involved in the design and implementation of a ground water monitoring program for the abandoned landfill. Geologic and ground water data within a one-mile radius of the landfill were collected and tabulated to evaluate the first aquifer beneath the facility and determine ground water flow direction. Nearby residential wells were field checked and the water levels measured. Residential wells adjacent to the landfill were sampled. In addition, eight gas probe wells were sited. Performed hydrogeologic interpretation, aquifer testing and analysis, development of ground water flow direction maps and calculated ground water gradient and velocities for the two-aquifer system.

SNOHOMISH RIVER CSO - REMOVAL OF LANDFILL REFUSE / STOCKPILING / SAMPLING
Everett, Washington
Provided on-site environmental construction services for the City of Everett as of the Snohomish River CSO project. The environmental phase of the project consisted of trenching through the northern portion of the former City of Everett Landfill to place a 12-inch and a 60-inch combined sewer and overflow line. The trench section through the landfill was about 500 feet in length to a depth of about 10 feet for the 12-inch line. Provided oversight of the excavation contractor and directed the stockpiling of the material. Stockpile samples were collected for waste classification profiling.

CATHCART LANDFILL HYDROGEOLOGIC AND METHANE INVESTIGATION
Snohomish County, Washington
Extensive investigation of ground water, surface water, and landfill gas migration at this 1000 ton/day solid waste facility. Sited and oversaw the installation of over 25 monitoring wells in three separate phases. Monitoring wells were completed in a shallow glacial aquifer and a deeper bedrock aquifer. A terrain-conductivity survey of the site was performed to assess the extent of leachate-impacted ground water and assist in locating additional wells. Interpreted water quality data using graphical and statistical methods. Recommended locations for large diameter extraction well for remediation of leachate-impacted ground water. Designed and directed installation and plumbing of the extraction well. Interpreted water quality data using graphical and statistical methods. Sited, designed and directed installation of over ten gas probe wells to monitor methane migration. In addition, interacted closely with Washington State Department of Ecology and local health department officials.

CATHCART LANDFILL WATER BALANCE
Snohomish County, Washington
Project involved in a water balance investigation at Cathcart Landfill. Purpose of developing water budget was to investigate leachate entrainment pathways and leachate migration. Development of water budget entailed review of as-built construction diagrams; interviews with people present during construction; gauging of precipitation, stream flow, underdrain and leachate collection; and calculation of ground water flow and evapotranspiration.

CATHCART LANDFILL HYDROGEOLOGIC STUDY
Snohomish County, Washington
Interpreted water quality and terrain conductance survey results to determine depth and extent of leachate-impacted ground water. Prepared water quality portion of hydrogeologic study report, which presented a comprehensive overview of monitoring results to date.

SAN JUAN COUNTY LANDFILLS
Orcas Island and Friday Harbor, Washington
Developed ground water monitoring plans to bring Orcas Island and Friday Harbor Landfills into compliance with state regulations for ground water at solid waste facilities. The Orcas Island facility is a 20-acre solid waste landfill located on glacial outwash and till. Friday Harbor Landfill is comprised of a closed solid waste area and an active ash fill portion, sited on bedrock. Performed preliminary hydrogeologic assessment, sited monitoring wells, oversaw monitoring well installations, performed pump tests, installed dedicated sampling pumps and developed sampling and analysis plan. Analyzed data and prepared report on lateral and vertical extent of leachate impacted ground water. County employees were familiarized with sampling techniques and equipment and to perform quarterly monitoring.

LAKE GOODWIN LANDFILL
Snohomish County, Washington
Lake Goodwin Landfill stopped accepting refuse in 1982 and final cover was placed in 1983. Developed a ground water monitoring plan for this closed facility specifying ground water monitoring well locations and depths and analytical testing parameters. Mr. Strunk was in charge of the monitoring well drilling and installation, well development, and installation of dedicated sampling pumps were completed. Performed pump tests on the wells to determine aquifer characteristics. Throughout the drilling process, reevaluated the ground water flow direction to ensure three wells were sited downgradient and one well upgradient of the waste area in accordance with the MFS for solid waste facilities. Interpreted data and prepared report. This project was completed under a grant from Department of Ecology and required close interaction with both the Department of Ecology and local health department.

REGIONAL LANDFILL
Snohomish County, Washington
Performed a hydrogeologic investigation to evaluate ground water flow conditions and water quality prior to the start of landfilling at a new regional solid waste facility. Project included the installation of ground water monitoring wells, aquifer testing and analysis of water quality data. Developed a ground water velocity model to aid county personnel in updating future ground water flow conditions.

LAKE STEVENS LANDFILL
Snohomish County, Washington
Assisted in preparation of ground water monitoring plans, compiled and interpreted regional well log data, and provided locations of eleven monitoring wells to monitor shallow, perched and deep, regional aquifers.

BRYANT LANDFILL
Snohomish County, Washington
Evaluated four years of ground water quality data for this closed facility and prepared monitoring report. Closure of Bryant Landfill was completed in 1989. Time series analysis and statistical techniques using graphical methods (box plots), single factor analysis of variance and student t tests were applied to the data to determine temporal and spatial trends in leachate impacted ground water. Prepared final report and provided recommendations for continued monitoring.

BOEING COMMERCIAL AIRPLANE GROUP
PROPOSED SITKA INDUSTRIAL LANDFILL
Sitka, Alaska
Performed a preliminary geotechnical investigation to determine the depth to bedrock and refusal on glacial sediments. Evaluated a 30-acre site to determine siting feasibility.

PROPOSED JARVIS STREET LANDFILL
Sitka, Alaska
Conducted a preliminary investigation to obtain information regarding the subsurface conditions at a site under consideration for a new landfill site by the City of Sitka. Scope of work included site reconnaissance, test probe and hand-auger explorations, geotechnical analysis and design recommendations.

SITKA LANDFILL SITING STUDY
Sitka, Alaska
Evaluated five alternative landfill sites under consideration for a new landfill in Sitka, Alaska. Work included site reconnaissance and mapping, test probe explorations, observation and description of existing site use, topographic conditions, surface water, adjacent property use and surficial geologic features. Developed siting criteria and performed a numerical ranking to aid in the planning/feasibility stage of the siting process.

LANDFILL EXPANSION AND CLOSURE
Sitka, Alaska
Performed geotechnical investigation for the proposed closure of the City of Sitka landfill. Work included geologic reconnaissance, subsurface explorations consisting of test pits, ground water level determinations, field permeability tests, water quality sampling and testing, water temperature measurements, laboratory soil testing, and engineering evaluations and development of design recommendations.

SITKA LANDFILL EXPANSION PROJECT
Sitka, Alaska
Conducted a preliminary geotechnical evaluation on a expansion site located adjacent to the existing landfill in Sitka, Alaska. The scope of work consisted of test pit and hand probe explorations, measurement of the ground water level in the test pits, laboratory soil testing, settlement analysis and engineering evaluations and development of design recommendations.

BENNINGTON LANDFILL
Bennington, Vermont
Performed a CERCLA Pre-Remedial Site Inspection, which included developing a work plan, conducting a sampling program of environmental media that included ground water, surface water, leachate, soil and sediment. Published in the Federal Register the Hazard Ranking System (HRS) scoring package. Provided EPA personnel and contractors with technical support and field assistance. Provided assistance in early Remedial Investigation/ Feasibility Study project start-up.

BURGESS BROTHERS LANDFILL
Woodford, Vermont
Initiated the responsible parties to conduct a hydrogeologic investigation to determine the nature and extent of contamination resulting from former disposal practices. Reviewed and commented on technical reports resulting from the study. Conducted sampling of ground water and surface water for compounds on the hazardous substance list. Performed geologic mapping to determine the orientation of bedrock fractures and possible pathways of preferred ground water flow.

OLD POULTNEY DUMP
Poultney, Vermont
Provided technical support to the town of Poultney to evaluate the environmental conditions of an inactive dump. Assisted in the development of a RFP, aided in the selection of a consultant, reviewed work plans, oversaw the installation of shallow and bedrock monitoring wells, developed and implemented a ground water and residential drinking water sampling program.

WILLIAMSTOWN LANDFILL
Williamstown, Vermont
Hazardous waste site investigation to determine the nature and extent of contamination resulting from the disposal of dry cleaning sludges. Site evaluation included geologic reconnaissance, subsurface exploration, soil gas survey, soil sampling for perchloroethene, design and implementation of long-term ground water monitoring program.

YOUNG LANDFILL
Highgate, Vermont
Performed CERCLA Pre-Remedial Site Inspection Sampling, which included analysis of Hazardous Substance List compounds from ground water, surface water, leachate, soil and sediment. Some investigations involved the installation of ground water monitoring wells.