PRELIMINARY
COMPREHENSIVE STORMWATER MANAGEMENT PLAN
FOR
SEA-TAC INTERNATIONAL AIRPORT
MASTER PLAN IMPROVEMENTS

APPENDIX F

STORMWATER QUALITY MANAGEMENT PLAN

Prepared for

PORT OF SEATTLE

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TRANSMITTAL FORM

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Date: **January 31, 2002**
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We are transmitting the following materials: **Appendix F – Stormwater Quality Management Plan**

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Sincerely,

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1. INTRODUCTION

1.1 PURPOSE

This Appendix to the Comprehensive Stormwater Management Plan was prepared for the Port of Seattle (Port) to guide the development of stormwater water quality facilities for projects associated with the Seattle Tacoma International Airport (STIA) Master Plan Update.

This appendix describes the evaluation of specific water quality BMPs to serve the Master Plan projects, and the resulting conceptual water quality plan. Included in this plan are:

- Descriptions of areas draining to the SDS that would require water quality treatment.
- Review of water quality data for existing Sea-Tac Airport stormwater outfalls.
- Summary of literature review of BMP pollutant removal efficiencies.
- Water quality criteria for stormwater discharge.
- Description of alternative BMPs to serve Master Plan project areas.
- A preliminary Reasonable Potential Analysis (RPA) to estimate the concentrations of potential stormwater pollutants from the proposed Third Runway.
- Criteria for BMP selection.
- Conclusions and recommendations on BMPs for stormwater quality management.

The Master Plan projects to be constructed over the period from 1997 to 2004 encompass several major revisions to the airport. Significant projects in the Master Plan include a new Third Runway and parallel taxiway, expansion of the parking garage, new remote parking lots, a new north terminal, reconstruction of Concourse A, development of the South Aviation Support Area (SASA), new air cargo facilities, a new air traffic control tower, and numerous minor projects. These projects will require extensive modifications to the existing Sea-Tac Airport Storm Drainage System (SDS) and Industrial Wastewater System (IWS).

1.2 GOALS AND OBJECTIVES

The overall goals of the Port's stormwater management program are:

- Design the Master Plan projects in accordance with all applicable stormwater management regulations.

- Verify that proposed projects do not cause increased flood peaks in Miller and Des Moines creeks at key points downstream (including the mouth).
- Verify that proposed projects do not violate Washington State surface water quality standards in Miller Creek or Des Moines Creek.
- Verify compliance with the Governor's Certificate (Locke 1997).
- Reduce wildlife attraction through innovative control outlet design and pond covering.
- Mitigate the potential impacts to low flows by providing low-flow augmentation in Des Moines Creek and acquiring surface water rights in the property acquisition area along Miller Creek.
- Verify compliance with the Port's National Pollutant Discharge Elimination System (NPDES) Permit (Ecology 1998).

The Port's NPDES waste discharge permit includes requirements for stormwater monitoring and reporting, preparation and maintenance of the Stormwater Pollution Prevention Plan (SWPPP) for Airport Operations, preparation of SWPPPs and monitoring plans for STIA construction projects, and future studies to characterize the toxicity of stormwater discharge. These NPDES requirements provide overall guidance for the evaluation and design of stormwater quality facilities for Master Plan projects.

1.3 STIA WATER QUALITY MANAGEMENT STANDARDS

The Port has established stormwater management standards for all Master Plan projects to ensure that all regulatory requirements for stormwater control and treatment are met, and that potential impacts from the projects are mitigated in accordance with the approved Final Environmental Impact Statement for the Master Plan Update (Port of Seattle 1997a), the Governor's Certificate (Locke 1997), and the NPDES Permit (Ecology 1998).

Specific STIA standards that apply to treatment of stormwater include:

- Design of individual Master Plan projects shall be in accordance with Best Management Practices (BMPs) contained in the Washington State Department of Ecology's (Ecology) *Stormwater Management Manual for the Puget Sound Basin* (Ecology 1992) or other equivalent stormwater manuals approved by Department of Ecology, such as the updated 1998 *King County Surface Water Design Manual* (King County, 1998).
- BMPs will be selected based on the Master Plan project area served, the Reasonable Potential Analysis (RPA), cost, maintenance, airport safety, and space requirements, as discussed in Sections 4 and 5.

2. EXISTING CONDITIONS

2.1 DRAINAGE

2.1.1 STIA Drainage: Storm Drain System and Industrial Waste System

The Storm Drainage System (SDS) consists of pipes, manholes, and catch basins that collect surface water runoff from pervious and impervious surfaces, including runways, taxiways, runway fields, most roof tops, and roadways.

The remaining areas of the airport, including the terminal aprons, certain portions of the terminal rooftop, the parking garage, and certain other areas drain to the IWS. Runoff entering the IWS flows to the Industrial Wastewater Treatment Plant (IWTP) located at the southwest corner of the airport. The IWTP consists of three storage lagoons (Lagoons 1, 2, and 3) and a treatment plant. Treated discharge flows to a pipeline that joins with the Midway Wastewater Treatment Plant (WWTP) effluent pipe for direct discharge into Puget Sound via a marine outfall. The Port recently submitted an engineering report to Ecology proposing that all IWS effluent be sent to the King County Department of Natural Resources Renton WWTP. This proposal has been made primarily to meet the glycol discharge limitations imposed in the STIA NPDES Permit.

Table 2-1 summarizes the total SDS and IWS drainage areas at STIA under current conditions. Drainage basin boundaries are shown in Figure 2 of the main report.

Table 2-1. Current Sea-Tac Airport SDS and IWS basin areas (1998).

	Area (acres)			
Basin	**Pervious**	**Impervious**	**Total**	**Drains to:**
SDS Basins				
SDN-1	3.4	12.8	16.2	Miller Creek
SDN-2	6.6	3.4	10.0	Miller Creek
SDN-3	49.5	20.4	69.9	Miller Creek
SDN-4	27.1	3.1	30.2	Miller Creek
SDE-4	48.9	100.8	149.7	Des Moines Creek
SDS-1	0.0	5.7	5.7	Des Moines Creek
SDS-2	8.9	0.6	9.5	Des Moines Creek
SDS-3	260.2	185.4	445.6	Des Moines Creek
SDS-4	46.0	19.7	65.7	Des Moines Creek
SDW-3	14.4	10.6	25.0	Des Moines Creek
B	42.1	1.2	43.3	Des Moines Creek
D	32.4	2.0	34.4	Des Moines Creek
Subtotal	540.9	364.3	905.2	--
IWS Basins				
IWS[1]	18.5	336.8	355.3	Puget Sound
TOTAL	**559.4**	**701.1**	**1260.5**	**--**

[1] Includes 16.1 acres of overflow to SDS-1 beginning at the 2-year storm, 14.5 acres of SDE-4 pumped to the IWS up to the 6-month/24-hour storm, and 35.6 acres of SDN-2 pumped to the IWS up to the 6-month/24-hour storm.

2.1.2 Receiving Systems: Miller and Des Moines Creeks

The Miller Creek watershed covers approximately 8.1 square miles of predominately urban area lying mostly within the cities of Burien and Sea-Tac, plus a small portion of Normandy Park and King County. The stream drains a relatively small portion of Sea-Tac Airport, including the north end of the runways and the air cargo areas north of the terminal. The upper reaches of Miller Creek, north of Highway 518, drain a gently rolling plateau between the Duwamish/Green River Valley and Puget Sound. In the lower reaches, the stream flows in a well-incised ravine, cut through glacial material, entering Puget Sound at the City of Normandy Park.

The Des Moines Creek watershed covers 5.9 square miles of predominately urban area lying mostly within the cities of SeaTac and Des Moines, plus a small area of King County. This stream drains most of Sea-Tac Airport, the city of Sea-Tac commercial area along International Boulevard (Highway 99), and residential areas in the remainder of the basin. Des Moines Creek is approximately 3.5 miles long; flowing from an elevation of about 350 feet and emptying into Puget Sound. Additional information on the Des Moines Creek watershed can be found in *1997 Des Moines Creek Basin Plan* (Des Moines Creek Basin Committee, 1997).

2.2 EXISTING BMPs

2.2.1 Source Control

Source control BMPs are required by the NPDES permit, and are in place throughout the SDS and IWS catchment areas, as described in the STIA SWPPP for Industrial Activities (Kennedy Jenks 1998). These BMPs are summarized in Table 2-2.

Table 2-2. STIA source control BMPs.

Activity	BMPs
Aircraft servicing	Restrict to IWS areas or drains blocked Store glycol in IWS areas Confine parking of lavatory waste trucks to IWS Identify and connect problem SDS areas to IWS Restrictions for fueling on taxiway Alpha Monitor SDS outfalls during deicing
Aircraft Movement Area (AMA) anti-icing/deicing	Minimize chemical use Use CMA/sand mixture for roadways
Snow storage	Operate pump stations to divert snowmelt to IWS
Spill control	Implement Spill Plan
Construction sites education/training	Require erosion and sediment control BMPs Restrict equipment servicing Encourage contractors to use secondary containment Concrete cutting and washout Provide contractor/inspector training
Erosion of bare ground surfaces in non-construction areas	Implement soil erosion and control BMPs in contractor staging areas Emphasize and enforce contractor responsibility for BMPs in contractor staging areas Control erosion from temporary soil stockpiles
Vehicle washing and maintenance	Prohibit vehicle washing in SDS areas Place signs in key locations Clean sumps in Taxi Yard annually Sweep Taxi Yard and control litter Maintain catch basin inserts
AMA maintenance	Sweep pavement frequently Inspect catch basin sumps annually and clean as needed Store and dispose of sediments properly Construct secondary containment for used engine fluids

Table 2-2 continued on next page.

Table 2-2 (continued). STIA source control BMPs.

Activity	BMPs
Inappropriate connections and discharges	Inspect outfalls for evidence of illicit connections
Temporary storage of surplus and used materials	Do not store liquids in west side yard Engineering Yard: Place signs on surplus storage Control entry of surplus materials
Landscape management	Strive to use environmentally benign chemicals Follow proper cleaning/disposal procedures Apply during dry periods Restrict use near waterways Incorporate BMPs in contractor specifications Implement IPM Plan Give priority to biological methods of pest management Apply fertilizer Conduct regular weeding and pruning Follow Ecology guidelines for herbicide application Apply herbicides/pesticides according to instructions Dethatch Trim ivy-covered areas Fertilize shrubs and trees by hand Do not use beauty bark in drainages Maintain stream corridors Prohibit Roundup use within 50 feet of a water body Do not apply pesticides or fertilizer on rainy days Avoid catch basin grates when applying fertilizer or pesticides
Tenant activities in SDS areas	Monitor and educate tenants De-ice aircraft according to procedures Encourage drip pans beneath fueling trucks if leakage is observed Sweep around dumpsters Store liquids in secondary containment Do not store used fluids or hazardous waste in SDS areas Do not maintain vehicles or equipment in SDS areas Inspect catch basin grates Require tenant water pollution control plans Ensure tenant compliance with Port SWPPP Require tenant spill control plans
Other Operational BMPs	Designate a SWPPP implementation monitor Conduct regular inspections Assemble Pollution Prevention Team Conduct SDS outfall monitoring Sign catch basins (dump no waste) Establish packing material source control

2.2.2 Treatment BMPs: Industrial Wastewater System

Because it collects and treats stormwater runoff, the IWS system and IWTP are considered a water quality BMP. Discharge from the IWTP is regulated by the Port's NPDES permit.

2.2.3 Treatment BMPs: Stormwater Drainage System

No formal water quality treatment BMPs are in place for the SDS. However, it is likely that incidental water quality treatment does occur by existing STIA facilities. Studies of these facilities have not been conducted to determine their effectiveness in removing pollutants.

Water quality treatment of existing stormwater runoff at STIA is likely to occur by the following mechanisms:

- Biofiltration along grassy drainage swales that run adjacent to the runways and taxiways
- Wet pond treatment in Lake Reba, located below the stormwater outfalls draining to Miller Creek
- Wet pond treatment in the Northwest Ponds, located below the stormwater outfalls draining to the West Branch of Des Moines Creek.

Drainage from the runways and taxiways flows through broad grassy swales en route to the SDS catch basins. Runoff from the pavement typically must pass over grassed areas before entering the swales, and then travel along the grass swale as much as 200-300 feet before discharging to a catch basin.

Lake Reba has permanent (dead) storage volume of approximately 4 acre-feet. Stormwater from all the north-draining outfalls (SDN-1, SDN-2, SDN-3, and SDN-4) flow through Lake Reba before entering Miller Creek. Lake Reba was constructed in 1973 for stormwater management purposes.

The Northwest Ponds have a permanent storage volume of approximately 10 acre feet. This facility receives drainage from most of the runway and taxiway area: SDS-2 SDS-3, SDW-3, Subbasin B, and Subbasin D. This facility was constructed several decades ago.

The remaining SDS outfalls in the airfield and terminal areas (SDS-1, SDS-4, and SDE-4) discharge directly to the East Branch of Des Moines Creek.

2.3 EXISTING STORMWATER QUALITY

As described in the STIA Annual Stormwater Monitoring Report (Port of Seattle 1997b), stormwater at the airfield outfalls under typical conditions has consistently lower pollutant concentrations than regional commercial areas, roadways, and residential areas (Booth and Horner 1995).

STIA unit loading estimates prepared by the Port were compared to unit loads published for other typical urban land uses (Table 2-3). These comparisons were performed for constituents for which unit loads have been published, and are intended to provide a representative comparison. The STIA unit loads are based upon the sampling history for each STIA subbasin, encompassing up to three years and 14 to 23 storm samples. The unit load is a rate term which estimates the annual amount of a pollutant generated or exported per unit of subbasin drainage area. Unit loads can be compared between sites and over geographical areas, as they reflect the general extent of activity, land disturbance, or other factors important in characterizing the water quality of a particular drainage area. Loading estimates are not precise and should be considered only as general order-of-magnitude estimates.

Table 2-3. Unit pollutant load estimates and comparisons.

Parameter	Unit Load(kg/ha-yr)[1] STIA Outfalls			Comparative Unit Load(kg/ha-yr)[2] Roads			Commercial			Single-Family Res.		
	min	median	max	min	median	max	min	median	max	min	median	max
TSS	14	21	30	281	502	723	242	805	1369	60	200	340
BOD5	12	15	19	na	na	na	na	na	na	na	na	na
Total copper	0.04	0.05	0.06	0.03	0.06	0.09	1.1	2.1	3.2	0.09	0.18	0.27
Total lead	0.01	0.03	0.08	0.49	0.78	1.1	1.6	3.1	4.7	0.03	0.06	0.09
Total zinc	0.13	0.2	0.32	0.18	0.31	0.45	1.7	3.3	4.9	0.07	0.13	0.2

1. For 12 outfalls: SDE-4, SDS1-SDS-4, SDW-3, B, D, SDN1-SDN4.
2. From Booth and Horner (1995).

As shown in Table 2-3, estimates of storm water unit loads show that the Port discharges considerably less pollution per unit area than typical roadways and commercial areas. Total suspended sediment (TSS) unit loads were more than one order of magnitude less than for commercial areas and roadways, and total metals (copper, lead, and zinc) were one to two orders of magnitude less than for commercial areas. STIA unit loads were also generally equal to or less than loads for residential areas.

In addition, STIA stormwater results for 15 pollutants (including fats, oil and grease (FOG), total petroleum hydrocarbons (TPH), TSS, ammonia, copper, lead, and zinc) were compared to other generally accepted reference comparators, including stormwater discharge data from a comprehensive regional study, the City of Bellevue Urban Runoff study (Bellevue 1984), and instream stormwater discharge data from Sturtevant Creek, a commercial/industrial subbasin monitored by the City of Bellevue (Bellevue 1996). These comparisons also demonstrate that

STIA stormwater concentrations for most pollutants are generally less than in stormwater from commercial land uses.

Further information on the characterization of STIA stormwater quality is provided in the Annual Stormwater Monitoring Report (Port of Seattle 1997b).

3. PROPOSED MASTER PLAN BMP ALTERNATIVES

3.1 DESCRIPTION OF BMP ALTERNATIVES

A review of available water quality treatment BMPs indicates that the following categories of BMPs are appropriate for new stormwater facilities associated with Master Plan Projects:

- Biofiltration swales and filter strips.
- Wet ponds and wet vaults, either combined with detention facilities or as separate facilities.
- Sand filters.

These alternatives, which are described below, fall within the "Basic Water Quality Menu" of the draft *1998 King County Surface Water Design Manual.* The Basic Water Quality Menu is generally applied to areas not draining to a sensitive lake, regionally significant stream reach, or sphagnum bog wetland. These alternatives are similar to the alternatives presented in Ecology's *Stormwater Management Manual for the Puget Sound Basin.* Any one of the King County Basic Water Quality Menu alternatives may be chosen to satisfy the water quality treatment requirement.

Another identified BMP in the Basic Water Quality Menu – stormwater wetland – was not considered appropriate for STIA because Port and Federal Aviation Administration policy does not allow creation of new wetlands in the vicinity of airports (See Section 4.1.2 of the main report).

3.1.1 Biofiltration Swales

A biofiltration swale is a long, gently sloped vegetated ditch designed to filter pollutants from stormwater. The primary pollutant removal mechanisms are filtration by grass blades which enhance sedimentation, and trapping and adhesion of pollutants to the grass and thatch. Grass is the common vegetation used. Figure 1 illustrates a conceptual design of a biofiltration swale located along a runway or taxiway.

Biofiltration swales are sized based on several variables:

- **Peak water quality design flow**. In Ecology's stormwater manual, the water quality design storm is defined as the 6-month, 24-hour design event (equivalent to 64% of the 2-year/24-hour event) as determined using the Santa Barbara Urban Hydrograph (SBUH) model. The draft 1998 King County manual defines the water quality design flow as 60% of the developed two-year peak flow, as determined using the King County Runoff Time Series (KCRTS) model. Both flow rates should be roughly equivalent.
- **Longitudinal slope, geometry, and design flow depth.** The swale is designed so that the base width is between 2 and 16 feet, water velocities do not exceed 1.0 feet per second,

maximum depths do not exceed 4 inches (2 inches if grass is mowed frequently), and the longitudinal slope is between one and 6 percent.

- **Required hydraulic residence time**. The swale length must be long enough to achieve a hydraulic residence time of 9 minutes; the minimum length is 100 feet.
- **Maximum hydraulic capacity**. If used as a primary conveyance, the swale should be designed to have a maximum water velocity of 5 feet per second during the 100-year flow.

Modifications to these criteria are required for continuous inflow biofiltration swales, where water enters the swale continuously along the side slope rather than discretely at the head. For these situations, the swale length and minimum hydraulic residence time are doubled.

A variation of the biofiltration swale – the filter strip – provides the same treatment mechanism. Biofiltration swales work well along roadways, driveways and parking lots. They are not suitable in situations where the swale is deep, or shading by vegetation limits the growth of grass.

A filter strip is a grassy slope located adjacent and parallel to an impervious area such as a parking lot driveway, or roadway. A filter strip generally requires more land area than a biofiltration swale because the flow depth through a filter is shallower than through a swale, and maximum velocities are lower. However, a filter strip is a viable treatment option in locations where grassy slopes already exist, such as long runways and taxiways. The following criteria apply:

- **Peak water quality design flow**. Same as biofiltration swale.
- **Longitudinal slope, geometry, and design flow depth.** Same as biofiltration swale, except that the longitudinal slope is between 1 and 15 percent, the maximum depth of flow is 2 inches, and the maximum velocity is 0.5 feet per second. There is no limit on filter strip width or length.
- **Required hydraulic residence time**. Same as biofiltration swale, except that there is no minimum length.

3.1.2 Wet Vaults and Wet Ponds

Wet vaults and ponds maintain a pool of water for most or all of the year. Stormwater entering the vault or pond is treated by physical and biological mechanisms during the relatively long residence time in the pond. The vault differs from the pond in that water storage is provided underground instead of in an open pond.

Several vaults have been constructed by the Port in the last few years for stormwater detention purposes; similar designs would be used for water quality treatment facilities. Because of the issue of wildlife attractance, open wet ponds have not been favored by the Port. To reduce wildlife hazards, wet ponds must be covered with a net or hard cover.

The size of wet vaults and ponds is based on the volume of runoff from the water quality design storm. In Ecology's stormwater manual, the volume of the permanent pool in a wet pond or vault is equal to the total volume of runoff from the 6-month, 24-hour design event (equivalent to 64% of the 2-year/24-hour event) as determined using the Santa Barbara Urban Hydrograph (SBUH) model. In the draft 1998 King County manual, the required wet pond or vault volume is 3 times the volume of runoff from the mean annual storm. In the Sea-Tac area, the mean annual storm precipitation is 0.47 inches; the total runoff volume for this rainfall depth could be readily calculated from flow monitoring data.

Numerous other criteria govern the geometry of the facilities, minimum and maximum depths, the need for baffles, additional storage for sediment accumulation, inlet and outlet configuration, and other elements of a wet pond or vault. These details are covered in the King County Surface Water Design Manual.

3.1.3 Sand Filters

A sand filter is a depression or basin with the bottom consisting of a layer of sand. Stormwater is treated as it percolates downward through the sand layer. Sand filters treat to a higher level of TSS removal than do the other water quality facilities. Because of this, basic sand filters are designed to filter 90 percent of the total runoff volume from a drainage catchment, rather than 95 percent of the volume assumed in other treatment BMPs.

Sand filters are typically constructed in areas where a large area of land cannot be dedicated to biofiltration swales, a large wet pond, or a large wet vault. They also are particularly attractive in areas of King County having the Sensitive Lake Protection Standard, which requires greater treatment efficiency; however, this standard does not apply to STIA.

Sand filters can be built as open basins, underground vaults, or linear perimeter trenches. Pre-settling is required prior to sand filtration if no other water quality or detention facility precedes the sand filter. Sand filters also need about 4 feet of head differential between the inlet and outlet to achieve the necessary hydraulic capacity.

A sand filter is designed with two parts: 1) a temporary storage reservoir to store runoff, and 2) a sand filter bed through with the stored runoff must percolate. Usually the storage reservoir is placed directly above the filter; the stored volume increases the hydraulic head over the filter surface which increases the rate of flow through the sand.

The King County Surface Water Design Manual contains a detailed design method that uses KCRTS to determine sand filter area and pond size based on individual site conditions. Sand filter design is based on Darcy's Law, which calculates the rate of flow through a soil media based on the hydraulic conductivity of the media and the hydraulic gradient. The filtration rate for a sand filter depends on the hydraulic head on the filter; it varies between 1.33 in/hr at 1 foot of head to 3.0 in/hr at 6 feet of head.

Numerous criteria govern the design of a sand filter. Those details are covered in the King County Surface Water Design Manual.

3.2 MASTER PLAN PROJECT AREAS REQUIRING BMPs

For the purposes of selecting water quality BMPs that are appropriate to the type of stormwater being treated, the Master Plan project areas are categorized into the following primary areas:

- Runway and taxiways draining to the Storm Drainage System (SDS)
- Non-runway/non-taxiway areas draining to the SDS
- Industrial Wastewater System (IWS).

Stormwater runoff from each of these areas is anticipated to have different water quality characteristics, and therefore the selected BMPs for each area may be different.

3.2.1 Runway and Taxiways: SDS

The newly constructed Third Runway and associated taxiways will drain primarily to a new SDS conveyance system (and through some existing systems) that will discharge to Miller and Des Moines creeks. In addition to routing through stormwater detention facilities, all runoff will be routed through at least one water quality BMP. Water quality BMPs that are considered to be appropriate for these areas include:

- Biofiltration swales
- Wet ponds and vaults

Sand filters are not considered appropriate because they are typically used only in areas where land area is limited. The runway and taxiways do not have this constraint. The analysis of these BMPs for treatment of runoff from Third Runway and taxiways is presented in Sections 4 and 5.

3.2.2 Non-Runway/Non-Taxiway Areas Draining to SDS

Parking lots, roads, and rooftop areas will be constructed or expanded as part of the Master Plan projects[1]. These projects vary widely in size, location, and timing of construction. Therefore these Master Plan projects will probably require individual treatment facilities rather than a single facility serving a large drainage area.

Runoff from parking lots and roads will be treated with at least one of the following BMPs:

- Biofiltration swales
- Wet ponds and vaults
- Sand filter

[1] Stormwater from STIA employee parking lots is not governed by Master Plan stormwater regulations.

Where possible, runoff from new Master Plan project areas will be isolated from other areas entering the SDS. The new water quality BMPs will be installed prior to discharge to the SDS system.

Rooftop runoff is considered to be non-contaminated, and will discharge directly to the SDS without treatment. This practice is consistent with the criteria contained in Ecology's and King County's stormwater manuals. Rooftop areas that will drain to the SDS include the main terminal, new cargo and hangar buildings, and the SASA rooftops. In addition, rooftop areas that currently drain to the IWS (e.g., older portions of the main terminal and the North Satellite) will also be rerouted to the SDS as part of the Master Plan projects and per the requirements of the SWPPP. However, runoff detention for these areas would still be provided.

3.2.3 IWS

Runoff from Master Plan projects in the terminal ramp (apron) areas, the SASA ramp area, air cargo ramp areas, and aircraft and ground vehicle maintenance areas will be directed to the IWS. The terminal parking garage also drains to the IWS because of its high vehicular use and the potential for fuel spills.

Source control BMPs are required for areas draining to the IWS. Discharge from the IWTP is regulated by the Port's NPDES permit.

4. PRELIMINARY REASONABLE POTENTIAL ANALYSIS

A preliminary Reasonable Potential Analysis (RPA) was performed to estimate predicted stormwater effluent pollutant concentrations from the proposed Third Runway. The RPA was performed using an unpublished guidance document by the Department of Ecology dated July 1997.

The analysis used existing STIA water quality data and a literature review of BMP performance. The Third Runway was chosen for the analysis because it will produce the largest amount of new runoff generated by Master Plan projects. The estimated pollutant concentrations were compared to water quality criteria .

The RPA was performed on June 30, 1998, in a working meeting attended by representatives of the Port and the Department of Ecology.

4.1 ESTABLISHMENT OF POLLUTANTS OF CONCERN

Five parameters were selected for analysis: turbidity, fecal coliforms, lead, zinc, and copper.

4.2 PREDICTED POLLUTANT CONCENTRATIONS

Data from outfall SDS-3 (outfall 005) was used for the analysis. Outfall SDS-3 drains the majority of the existing runways, with minor inputs from STIA and public roads; pollutant concentrations from this outfall are assumed to be similar to those from the proposed Third Runway. Outfall SDS-3 NPDES monitoring data from 1994 through 1998 was used.

As per the guidance document provided by Ecology, the 95th percentile effluent pollutant concentration was calculated for the existing data (using lognormally transformed data). These values are presented in Table 4-1.

Table 4-1. Stormwater pollutant concentrations for STIA Outfall SDS-3 (95th percentile values), and estimated acute water quality criteria for storm flows in Miller and Des Moines Creeks. Metals criteria at 70 ppm hardness are included for reference.

Parameter	Units	95th pctile 1994-98 data	Criteria DesMoines	Criteria Miller	Criteria 70 ppm hardness
Fecals	CFU/100mL	122	50	50	-
Turbidity	NTU	15.9	30[1]	30[1]	-
Total Copper	ppb	86.3	6.7[2]	4.4[2]	12.2
Total Lead	ppb	11.3	21.9[2]	12.6[2]	43.7
Total Zinc	ppb	107	48.8[2]	33.7[2]	84.6

[1] Turbidity criteria are based on estimated storm flow background conditions observed in Miller Creek.

[2] Metals criteria are calculated using 10th percentile values of hardness in Miller Creek (23 ppm) and DesMoines Creek (35.6 ppm).

4.3 ESTABLISHMENT OF CRITERIA

Criteria reflecting Washington State water quality standards were calculated for Miller and Des Moines Creeks (see Table 4-1). The fecal coliform criterion is the limit set for all class AA waters. The turbidity criterion is based on background turbidity observations made in Miller Creek during storm flows. The metals criteria were conservatively based on 10th percentile hardness values of 23 ppm in Miller Creek, and 35.6 ppm in Des Moines Creek. For comparison, metals criteria were calculated at a typical hardness of 70 ppm.

4.4 ESTIMATION OF BMP EFFECTIVENESS

The BMPs discussed in Section 3.2.1 and 3.2.2 were included in the analysis. Additionally, for reference, the treatment effectiveness of detention alone (dry ponds or vaults) was considered.

Expected pollutant removal efficiencies for the selected BMPs were determined based on results of a literature review (Table 4-2). The maximum and minimum ends of the treatment range, and a recommended value (a best judgment of the estimate), were estimated. The literature review was not comprehensive, and consisted of other compilations and project-specific studies. The values chosen for the RPA were weighted heavily on studies done after 1990.

Table 4-2. Expected BMP pollutant removal efficiencies.

	Pollutant Removal Efficiency (percent)											
	Detention Pond[1]			Bioswale			Sand Filter			Wet pond/Vault		
Parameter	min	max	Recommended value	min	max	Recommended value	min	max	Recommended value	min	max	Recommended value
Fecals	74[a]	100[b]	80[b]	20[b]	40[b]	30[b]	22[e2]	69[e2]	50[e2]	0[e3]	90[e3]	45[a, e3]
Turbidity[2]	-	-	-	-	-	-	-	-	-	-	-	-
Total Copper	11[c]	54[c]	25[c]	42[e1]	46[b]	45[b]	19[a]	70[e2]	30[a, e2]	10[e3]	47[f]	40[a, e3, f]
Total Lead	2[c]	79[c]	40[c]	62[e1]	67[b]	65[b, e1]	65[a]	85[a, e2]	75[a, e2]	10[e4]	95[e4]	70[a, e4, f]
Total Zinc	6[c]	80[d]	30[c, d]			63[b]	33[e2]	80[a, e2]	55[a, e2]	20[e4]	95[e4]	60[a, e4, f]

[1] Detention pond was included with most of the BMPs reviewed; therefore, its treatment efficiency should not be compounded with that of other BMPs.
[2] No data was available for turbidity.

References

a. Austin (1990).
b. Marselek, et al. (1996)
c. Stanley (1996)
d. Wu et al. (1996)
e. UW PEPL (1996), reporting
   1. Unpublished studies at Mountlake Terrace, WA and Dayton Ave., Seattle, WA.
   2. Austin (1996), Austin (1990), Horner (1995), Alexandria (1993).
   3. Minton (1993)
   4. USEPA (1993)
f. Comings (1998)
Other references considered in this review included Metro (1992), Bellevue (1998), and Kulzer (1989)

It is assumed that the maximum treatment efficiency represents BMPs installed and operated under nearly ideal conditions with regular maintenance. The minimum efficiency is assumed to represent BMPs inappropriately designed or applied, with poor maintenance. The recommended value is assumed to represent BMPs installed per standard design under typical conditions, with regular maintenance.

No literature was available on pollutant removal efficiency of wet vaults. Consensus was reached that pollutant removal efficiency for wet vaults would be considered similar to that of wet ponds for the pollutants of concern. This is because the primary removal mechanism for these pollutants is settling, rather than biological uptake.

4.5 ESTIMATION OF PREDICTED EFFLUENT POLLUTANT CONCENTRATIONS

Estimated effluent pollutant concentrations (maximum, minimum, and recommended value) for the Third Runway drainage area were calculated based on historical pollutant concentrations in runway runoff (Table 4-1) and treatment efficiencies (Table 4-2). The results are summarized in Table 4-3). Using the assumptions described above, pollutant concentrations for all constituents analyzed except copper are predicted to be at approximately the criteria values or less.

Table 4-3. Predicted stormwater effluent pollutant concentrations for the Third Runway drainage area after BMP application.

	Predicted Effluent Pollutant Concentrations											
	Detention			Bioswale			Sand Filter			Wet pond/Vault		
Parameter	max	min	Recommended value	max	min	Recommended value	max	min	Recommended value	max	min	Recommended value
Fecals	32	0	24	98	73	85	95	38	61	122	12	67
Turbidity	-	-	-	-	-	-	-	-	-	-	-	-
Total Copper	77	40	65	50	47	47	70	26	60	78	46	52
Total Lead	11	2	7	4	4	4	4	2	3	10	1	3
Total Zinc	101	21	75			40	72	21	48	86	5	43

4.6 RECEIVING WATER CONDITIONS

Table 4-4 summarizes typical background (upstream) storm flow pollutant concentrations in Des Moines Creek. These data indicate that typical storm flow pollutant concentrations in Des Moines Creek exceed the criteria used in this report (Table 4-1) (Des Moines Creek Basin Committee 1997), and are higher than the predicted effluent pollutants concentrations in Third Runway stormwater runoff (Table 4-3). No data are available for Miller Creek. Because the Miller Creek and Des Moines watersheds are similar, it was assumed that stormwater quality in Miller Creek would be similar to that reported for Des Moines Creek. No mixing zone dilution was analyzed for the two receiving streams.

Table 4-4. Des Moines Creek stormwater quality[1].

Parameter	Units	Mean 1994-1995	Mean 1995-1996
Fecals	CFU/100mL	838	411
Turbidity	NTU	21	17
Total Copper	ppb	25.2	22.3
Total Lead	ppb	15.4	10.9
Total Zinc	ppb	104	487

[1] Results are for monitoring at South 200th Street, based on the City of Des Moines Water Quality Monitoring program, as reported in the Des Moines Creek Basin Plan (Des Moines Creek Basin Committee 1997).

5. BMP SELECTION PROCESS

5.1 CRITERIA FOR BMP SELECTION

In addition to BMP effectiveness (as analyzed in the RPA in Section 4), other criteria used to guide selection of appropriate BMPs at STIA include safety, cost, space requirements, and maintenance considerations. Estimation of BMP effectiveness is discussed in Section 4. The additional criteria are discussed in the following sections.

5.1.1 Safety

Wildlife attraction to open basins and ponds

The Port is very concerned about the issue of wildlife attractants to open stormwater basins and ponds. The Federal Aviation Administration's (FAA) Advisory Circular 150/5200-33 describes FAA policy regarding wildlife attractants near airports (FFA 1997). The circular states that any land activity or land use on or near an airport that threatens aircraft safety by attracting or sustaining hazardous wildlife is an incompatible land use. Examples of wildlife species that pose a threat to aircraft safety include waterfowl and flocking birds such as starlings and blackbirds.

The FAA and the Port are mandated to adhere to established guidelines that prevent creation of hazardous wildlife attractants on or near STIA. The Port has adopted a standard that stormwater detention basins and ponds are not to have open water for more than 24 hours per year, averaged over the long-term, by using pond covers and hydraulically efficient outlets. Therefore, uncovered wet ponds were not considered a feasible alternative.

Proximity to aircraft movement areas

FAA Advisory Circular 150/5300-13, Airport Design, identifies three zones that can impact the siting of stormwater facilities: (1) Runway Safety Area (RSA), a defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplane passengers if a plane undershoots, overshoots, or leaves the runway; (2) Runway Object Free Area (ROFA), an area on the ground, centered on the runway, taxiway, or taxilane centerline, that is provided to enhance the safety of the aircraft operation by remaining free of objects, except for objects that need be located in the ROFA for air navigation or aircraft ground maneuvering purposes; and (3) Runway Protection Zone (RPZ), a safeguarded area off the runway end created to enhance the protection of people and property on the ground. Objects may be located within the RPZ if they do not attract wildlife and are outside the ROFA. Detailed information on proximity to aircraft movement areas is provided in Section 4.1.3 of the Comprehensive Stormwater Management Plan.

Other considerations

Additional safety considerations include confined space entry procedures necessary for entry of structures such as wet vaults, and fencing and signage for open ponds.

5.1.2 Cost

Wet vaults and sand filters are typically more expensive than biofiltration swales and wet ponds.

5.1.3 Space Requirements

Wet ponds typically require a larger area relative to biofiltration swales, sand filters, and wet vaults. Wet ponds require a flat topographic area. Wet vaults can be variable in size and can be used at almost any location; a chief advantage of wet vaults is that they can be installed directly under the utilized area (i.e., under a parking lot). Biofiltration swales work well along roadways, driveways, and parking lots but do not work well for projects that concentrate runoff from large areas into a single conveyance. Sand filters are typically used in situations where land area is limited.

5.1.4 Maintenance Considerations

The maintenance requirements of BMPs are an important aspect. Preventative maintenance practices should include regular inspections. Maintenance considerations are briefly discussed below for specific BMPs. Detailed maintenance requirements are provided in the King County Surface Water Design Manual.

For wet ponds, maintenance of sediment forebays and attention to sediment accumulation within ponds is important. Appropriate procedures need to be followed for testing and disposal of dredged sediment. Debris removal can be achieved through the use of trash racks or screening other devices. Floating debris and accumulated petroleum products should be removed as needed and properly disposed.

Confined space entry procedures need to be followed when entering a wet vault. Accumulated sediment must be removed and disposed of accordingly. Floating debris and accumulated petroleum products should be removed as needed and properly disposed.

Typical biofiltration swale maintenance includes routine mowing in the summer to promote growth and pollutant uptake, sediment and debris removal, and repair of eroded or scoured channel sections. To be effective, the depth of the stormwater during treatment must not exceed the height of the grass, so maintenance personnel must not cut below the design flow. Cuttings should be removed promptly and disposed appropriately. Accumulated sediment must be removed (and properly disposed) as they may interfere with biofilter operation. Annual sediment removal and spot reseeding is typically necessary.

Since sand filters are subject to clogging by fine sediment, oil and grease, and other debris (e.g., trash and organic matter such as leaves), they should be inspected at least every six months during the first year of operation and immediately following a storm event. Accumulated sediment must be removed and properly disposed.

5.2 ADVANTAGES AND DISADVANTAGES OF SPECIFIC BMPs

A summary matrix table rating the selection criteria discussed above is provided in Table 5-1 for the individual BMPs.

Table 5-1. Summary criteria rating matrix for individual BMPs.

	Criteria				
BMP	Effectiveness	Safety	Cost	Space	Maintenance
Wet pond (covered)	2	1	2	3	1
Wet Vault	2	2	3	1	2
Biofiltration Swale	2	1	1	2	1
Sand Filter	2	1	3	2	3

1 = Good: BMP is preferable with regard to the criterion
2 = Moderate: BMP adequately meets the criterion
3 = Fair: BMP may have one or more disadvantages with regard to the criterion

5.2.1 Wet Ponds

The advantages of wet ponds are that they can be constructed to a very large size, they are among the least expensive options for large stormwater facilities, and maintenance is relatively low. The wet ponds must be covered due to potential wildlife attractance hazards of open water near the airport. Covering of ponds creates potential interference with pond operation and maintenance and increased costs. Other disadvantages include the difficulty in finding level sites for large ponds, and the need to plan ahead for detention facility construction if multiple Master Plan projects will be served by the facility.

5.2.2 Wet Vaults

Wet vaults have advantages in that they can be variable in size and can be constructed at almost any location with only minimal conflicts with existing land uses, they do not create a wildlife attractant hazard, and they can be built concurrently with construction of the Master Plan project they intend to serve, which makes scheduling more efficient. The disadvantages of underground vaults are that they are expensive, provide little economy of size when structures exceed a few acre-feet in volume, and maintenance is more difficult within confined space of the vault.

5.2.3 Biofiltration Swales and Filter Strips

Biofiltration swales have advantages that they work very well in proximity to roadways, driveways and parking lots, they can be designed for both treatment and conveyance of on-site stormwater flow which can reduce costs, and they are relatively inexpensive compared to the other BMPs. Disadvantages include that they are not suitable as deep swales or in heavily shaded areas, they do not work as well when receiving runoff from large areas concentrated into a single conveyance (a single bioswale typically should not serve more than five acres of impervious surface), and design velocities cannot be high (typically should not exceed 1.0 foot per second).

5.2.4 Sand Filters

Sand filters have advantages in that they treat stormwater to a higher level of TSS removal relative to other water quality facilities. Disadvantages include they are designed to filter less runoff volume relative to other treatment BMPs, they should not be used in situations where heavy sediment loads are anticipated as the surface of the filter will clog, and adequate hydraulic head is required to operate the filter (minimum four feet between filter inlet and outlet). Sand filters typically are only used in situations where land area is limited.

6. PREFERRED ALTERNATIVES

The results of the RPD analysis demonstrated that the treatment BMPs considered for the Master Plan projects – biofiltration swales, wet ponds and vaults, and sand filters – all have similar pollutant removal effectiveness. It was concluded that these BMPs should produce stormwater effluent that would meet Washington State water quality standards. Since they provide equal treatment performance, BMPs for specific Master Plan project areas can be chosen by other design criteria including cost, space, maintenance, and safety criteria as discussed in Section 5.

6.1 RECOMMENDED TREATMENT BMPs

Recommended treatment BMPs for specific Master Plan project areas are described below.

<u>6.1.1 Third Runway And Taxiways</u>

Biofiltration swales are the preferred BMP for treating stormwater runoff from the third runway and other areas. Because biofiltration swales are not recommended for receiving point discharges from large areas of impervious surface, runoff from the third runway area should be distributed to numerous swales. Design of biofiltration swales should be based on guidance contained in Ecology's stormwater manual or the King County Surface Water Design Manual.. A conceptual drawing showing a typical swale application is contained in Figure 1.

In areas where limited space or other constraints preclude the use of swales to treat third runway runoff, wet vaults, covered wet ponds, or sand filters may be used.

<u>6.1.2 Other Master Plan Project Areas</u>

Wet vaults are the preferred BMP for treating stormwater runoff from parking lots, roads, and other pollutant-generating surfaces constructed as part of the Master Plan Projects. This is primarily due to constraints imposed by airport operations in the vicinity of these projects. Alternatively, if found to be feasible, sand filters may also be used.

Rooftop runoff is considered to be non-contaminated, and can be discharged directly to the SDS without treatment. However, detention of rooftop drainage will still be required if necessary.

In general, stormwater runoff from terminal ramp (apron) areas, the SASA ramp area, air cargo ramp areas, and aircraft and ground vehicle maintenance areas will be discharge to the IWS for treatment at the IWTP. Runoff entering the IWS will not require treatment BMPs. In situations where contaminated runoff contains surfactants, such as from car washes, which are incompatible with the IWTP treatment process, it is recommended that this drainage be routed to the sanitary sewer.

6.2 SOURCE CONTROL BMPs

Source control BMPs will be incorporated into the Master Plan stormwater management projects as required by the SWPPP. Within the airfield areas there should be very few, if any, cases where stormwater source control BMPs are required for the SDS. Runoff entering the IWS will require source control BMPs, as appropriate to the activity within the drainage area. Should they be identified, appropriate source control BMPs will be installed in accordance with the requirements of the SWPPP.

7. REFERENCES

Alexandria, City of. 1993. Alexandria Supplement to the Northern Virginia BMP Handbook. Alexandria, Virginia.

Austin, City of. 1990. Removal Efficiencies of Stormwater Control Structures. Environmental Resource Management Division; Environmental and Conservation Services Department. Austin, Texas.

Austin, City of. 1996. Unpublished data. Austin, Texas.

Bellevue, City of. 1998. Unpublished data for Lakemont Boulevard. Storm and Surface Water Utility. Bellevue, Washington.

Booth and Horner. 1995. Fundamentals of Urban Surface Water Management, Chapter IV. University of Washington Engineering Professional Programs, Seattle, Washington.

Comings, K.J. 1998. Stormwater Pollutant Removal by Two Wet-Ponds in the Lake Sammamish Watershed. M.S. Thesis, University of Washington. Seattle, Washington.

Des Moines Creek Basin Committee. 1997. Des Moines Creek Basin Plan. Des Moines Creek Basin Committee (City of SeaTac, City of Des Moines, Port of Seattle, and King County). Seattle, Washington.

Federal Aviation Administration (FAA). 1997. Hazardous Wildlife Attractants on or Near Airports. U.S. Department of Transportation, Federal Aviation Administration. May 1, 1997. [Advisory Circular 150/5200-33].

Horner, R.R. and C. Horner. 1995. Design, Construction, and Evaluation of a Sand Filter Stormwater Treatment System, Part II, Performance Monitoring. Alaska Marine Lines, Seattle, WA.

Kennedy Jenks, Inc. 1998 (in press). Seattle-Tacoma International Airport Stormwater Pollution Prevention Plan for Industrial Activities. Seattle, Washington.

King County. 1998 (in press). Surface Water Design Manual. Water and Land Resources Division, Department of Natural Resources. Seattle, Washington.

Kulzer, L. 1989. Considerations for the Use of Wet Ponds for Water Quality Enhancement. Office of Water Quality, Municipality of Metropolitan Seattle. Seattle, Washington.

Locke, G. 1997. Letter from Gary Locke, Governor of Washington, to Rodney Slater, Secretary of the U.S. Department of Transportation. Re: State Certification of Compliance with Applicable Air and Water Quality Standards. State of Washington, Office of the Governor. Olympia, Washington.

Marselek, J., J.B. Ellis, and B. Urbonas. 1996. Stormwater Detention and BMPs. Journal of Hydraulic Research, 34: 802.

Minton, G.R, Herrera Environmental Consultants, Inc., and R.W. Beck, Inc. 1993. The Selection and Sizing of Treatment BMPs in New Developments to Achieve Water Quality Objectives. King County Surface Water Management Division, Department of Public Works. Seattle, Washington.

Municipality of Metropolitan Seattle (Metro). 1992. Biofiltration Swale Performance, Recommendations, and Design Considerations. Water Pollution Control Department. Seattle, Washington.

Pitt, R, and P. Bissonette. 1984. Bellevue Urban Runoff Program. Storm and Surface Water Utility. Bellevue, Washington.

Port of Seattle. 1996. Annual Stormwater Monitoring Report for Seattle-Tacoma International Airport for the Period July 1, 1995 through June 30, 1996. Seattle, Washington.

Port of Seattle. 1997a. Final Environmental Impact Statement for the Master Plan Update. Seattle, Washington.

Port of Seattle. 1997b. Annual Stormwater Monitoring Report for Seattle-Tacoma International Airport for the Period July 1, 1996 through May 31, 1997. Seattle, Washington.

Stanley, D.W. 1996. Pollutant Removal by a Stormwater Dry Detention Pond. Water Environment Research, 68 (6): 1076-1083.

University of Washington Professional Engineering Practice Liaison Program (UW PEPL). 1996. Stormwater Treatment by Media Filtration; Manual from Short Course held May 14-15, 1996.

USEPA. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. EPA-840-B-92-003. Office of Water. Washington D.C.

Washington Department of Ecology. 1998. National Pollutant Discharge Elimination System Permit Number WA-002465-1, issued February 20, 1998. Olympia, Washington.

Washington State Department of Ecology (Ecology). 1992. Stormwater Management Manual for the Puget Sound Basin, The Technical Manual. Washington Department of Ecology. Olympia, Washington.

Wu, J.S., R.E. Holman, and J.R. Dorney. 1996. Systematic Evaluation of Pollutant Removal by Urban Wet Detention Ponds. Journal of Environmental Engineering, 122 (11): 983-988.

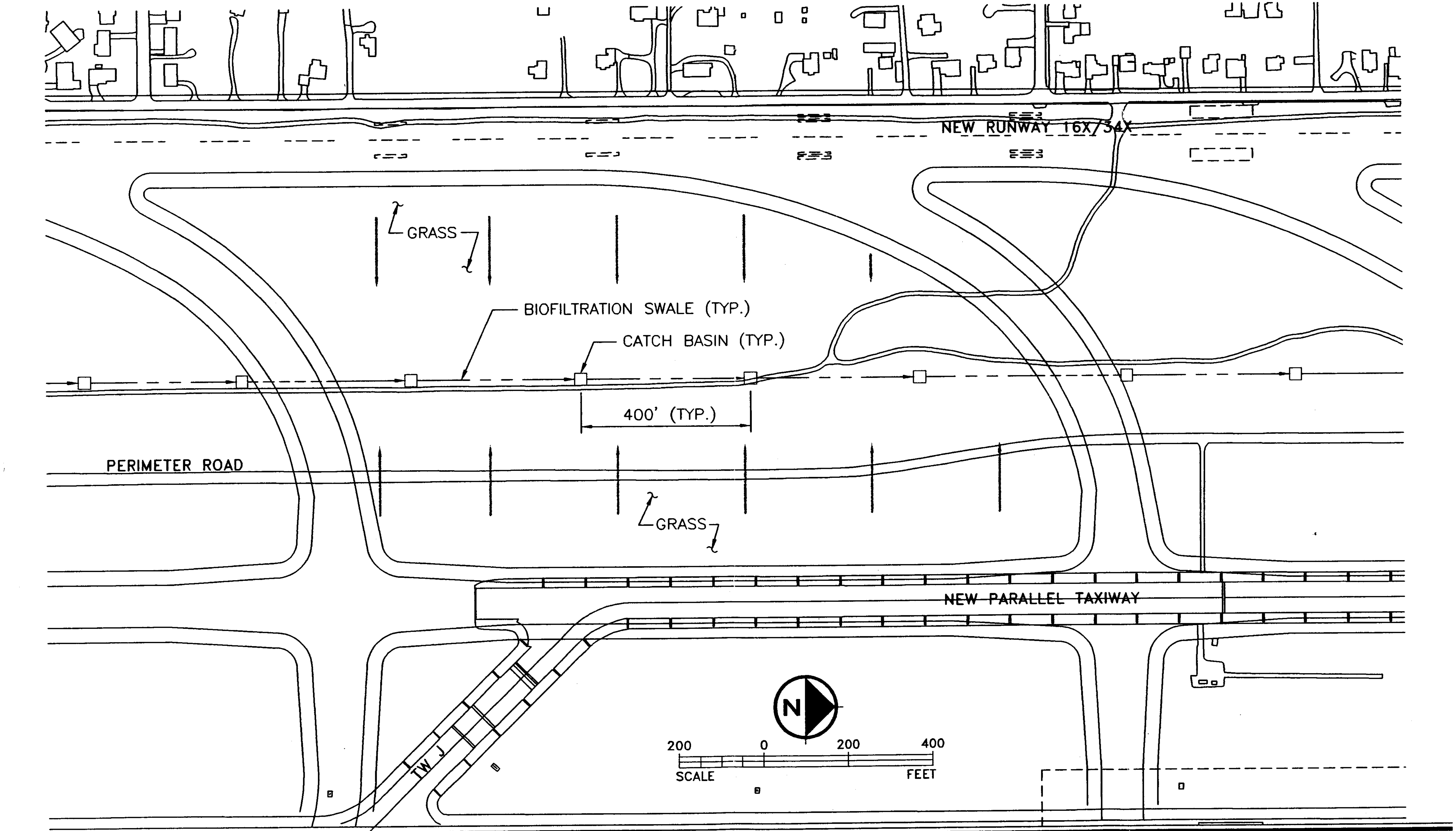

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Figure 1
Typical Biofiltration Swale
Plan

AR 033689

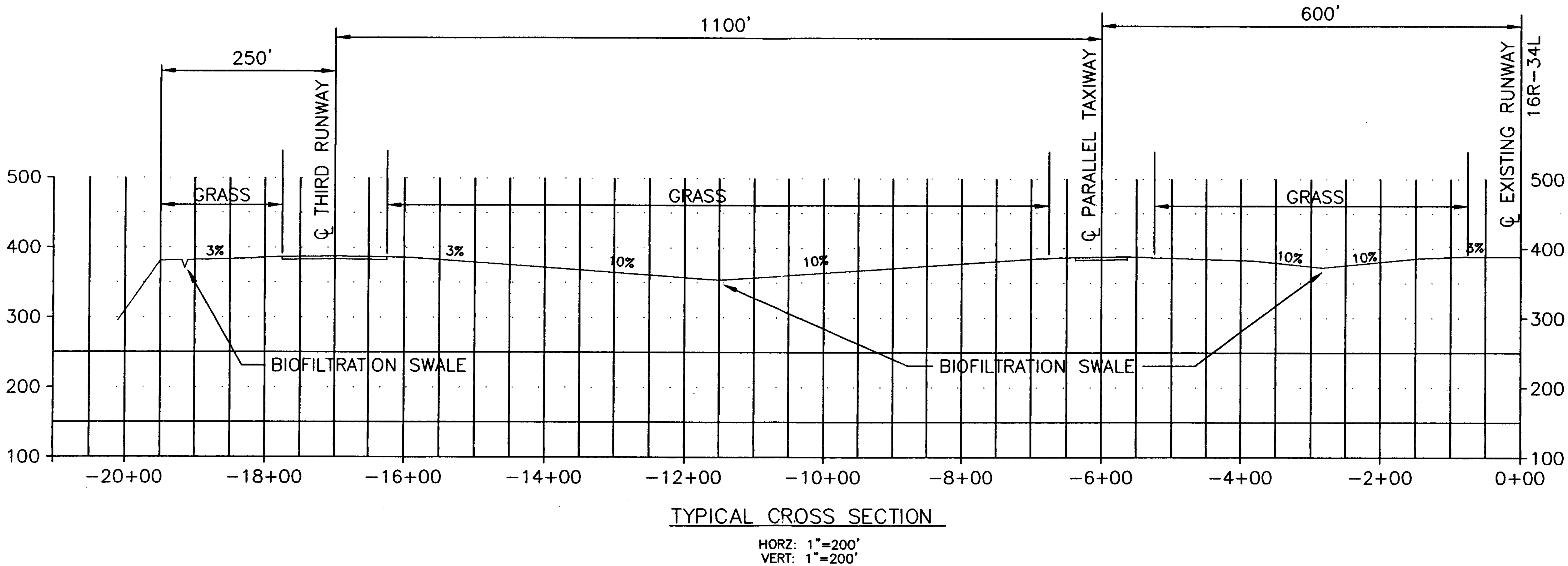

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Figure 2
Typical Biofiltration Swale Section

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