Port of Seattle

November 16, 2001

Ms. Ann Kenny
Washington Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

RECEIVED
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FOSTER PEPPER & SHEFELMAN PLLC

Re: Seattle-Tacoma International Airport
Washington Department of Ecology
§ 401 Water Quality Certification
Order #1996-4-02325
Condition E.3

Dear Ms. Kenny:

The Port of Seattle presents the enclosed *Third Runway Embankment Seepage and Groundwater Monitoring Plan* to the Washington Department of Ecology in satisfaction of the above noted Order, Condition E.3. Condition E.3 requires the Port to prepare for Ecology review and written approval a monitoring plan "designed to detect impacts of the fill embankment to the receiving water and ground water during fill placement and post fill placement."

Please review the plan and provide the written approval required. Please feel free to refer comments and questions to Paul Agid, 206-439-6604, agid.p@portseattle.org.

Sincerely,

E Leavitt

Elizabeth Leavitt
Manager, Aviation Environmental Programs

xc: Gillis Reavis, Martin Brown Inc.
Tom Walsh, Foster Pepper Shefelman
Jim Lynch, Stoel Rives
Michael Kenrick, Hart Crowser Inc.
C. Linn Gould, Erda Environmental
Robin Kordik, Paul Agid, Laurie Havercroft, Tom Newlon, Port of Seattle

Seattle-Tacoma
International Airport
P.O. Box 68727
Seattle, WA 98168 U.S.A.
TELEX 703433
FAX (206) 431-5912

THIRD RUNWAY EMBANKMENT FILL MONITORING PLAN

401 Certification Condition E.3

Port of Seattle
November 2001

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SEATTLE-TACOMA INTERNATIONAL AIRPORT
THIRD RUNWAY EMBANKMENT
SEEPAGE AND GROUNDWATER MONITORING PLAN

1.0 INTRODUCTION AND BACKGROUND

In accordance with the Department of Ecology's (Ecology) Water Quality Certification for U.S. Army Corps of Engineers Public Notice 1996-4-02325 (Amended-1), Condition E.3, "Post Construction Monitoring", dated September 21, 2001, the Port of Seattle (Port) will monitor water quality from the Third Runway Embankment. The text of Condition E.3 from the 401 Water Quality Certification is shown in Exhibit 1. A draft of this Embankment Fill Monitoring Plan (EFMP) is due to Ecology by November 20, 2001.

The Post Construction Monitoring condition requires the monitoring of both runoff and seepage from the Third Runway embankment in order to ensure that infiltrate does not "result in impacts to wetlands or other waters of the state." The monitoring of runoff from the surface of the embankment is not discussed in this EFMP. Such runoff, which is only expected to occur during large rain events, is collected and routed through detention facilities and discharged through permitted stormwater outfalls. The Port's National Pollution Discharge Elimination System (NPDES) permit (WA-002465-1) requires it to monitor surface water runoff, including runoff from industrial activities (e.g. runways and taxiways). A more detailed discussion of the NPDES monitoring program can be found in section S2 of the Port's NPDES permit and in the Port's Procedures Manual for Stormwater Monitoring. The purpose of this EFMP is, therefore, to track the quality of water that flows through the embankment and expresses itself as either seepage discharging from the bottom of the fill area or as groundwater.

Groundwater monitoring will begin in winter 2001-2002 from permanent well locations near the planned toe of the completed embankment. Groundwater monitoring will provide an understanding of background baseline water quality and will allow tracking of any changes in groundwater quality over the duration of embankment construction.

Seepage monitoring will initially be conducted at interim monitoring locations. Completion of embankment construction is expected to occur within 5-7 years after the initiation of construction permitted under the 401 Water Quality Certification. During construction, embankment seepage flowing from the drainage layer will be ephemeral, and discharge locations will be discontinuous as the embankment is modified by further construction and implementation of construction stormwater BMPs. Seepage quality monitoring during construction will, therefore, be focused on relatively stable temporary seepage locations identified at the toe of interim embankment slopes, where seepage can be observed and monitored in relatively undisturbed conditions for a period of at least 12 months. Post construction seepage monitoring will be initiated at proposed permanent locations after final construction in those embankment areas is completed and consistent seepage is observed.

The proposed EFMP establishes a phased monitoring approach to determining the potential impacts of embankment fill on water quality. The phased approach establishes a flexible, risk-based monitoring regime that becomes increasingly conservative as potential impacts to water quality are detected. Two types of phasing are proposed for both groundwater and seepage monitoring. The first type of phase, called "tiers," provides flexibility in the location from which samples are collected. In the first tier, samples are obtained from sampling points very close to the potential source of discharge from the embankment. This provides a conservative opportunity to observe water quality constituents that could reach surface water above the applicable criteria. In the second tier, sample locations could be established further downgradient from the source of discharge, to demonstrate that attenuation and dilution mechanisms are occurring. In the last tier, the samples would be obtained from locations near the resources to be protected (i.e., the nearby creeks and wetlands). The second type of phasing, called "stages," provides similarly sequenced flexibility in data collection, analysis, and evaluation tools within each tier.

This EFMP is divided into seven sections. Following this introductory section, the embankment conceptual site flow model is described in Section 2. Groundwater monitoring that occurs during construction is discussed in Section 3. Section 4 describes monitoring of seepage from interim monitoring locations during sequential construction phases. Section 5 describes both groundwater and seepage monitoring that occurs post construction. The monitoring report and contingency plan are discussed in Sections 6 and 7 respectively. Appendix Sections A-C include the field and laboratory procedures.

2.0 EMBANKMENT CONCEPTUAL SITE AND FLOW MODEL

This section describes the embankment fill and how water is anticipated to flow through it. The embankment is designed to create an elevated, relatively flat surface upon which the Third Runway will be built. As shown on Figures 1 and 2, the total length of the embankment will extend approximately 8,700 feet, bounded by the relocated S. 154th Street to the north and extending beyond S. 176th Street to the south. The width of the fill ranges from 40 feet at its narrowest point in the south end to approximately 1,400 feet at the widest point. The east margin of the fill will abut the existing airfield; the west margin of the fill will either be sloped or bounded by a mechanically stabilized earth (MSE) wall, depending on the location. The fill thickness will range from several feet to 165 feet thick. The volume of the fill that is required for the construction of the Third Runway embankment is approximately 17 million cubic yards. Embankment soil placement is designed to be both geotechnically suitable as foundation material for the Third Runway and to accommodate infiltration of water through the fill in all seasons. Fill will consist of approximately 40 percent sand and gravel that is relatively silt-free and about 60 percent silty sand and gravel mixtures.

A bottom drainage layer, consisting of an approximate 3-foot thickness of free-draining sand and gravel, has been included in the fill embankment design (Figure 3). This drainage layer will generally be laid on the existing ground surface. The drainage layer will prevent groundwater pressures from building up within the embankment and direct groundwater flow away from the embankment fill. Water may enter drainage layer from above, due to infiltration through the embankment fill, and from below as groundwater inflow in the form of seepage from the existing slope or existing shallow groundwater discharge zones that will be buried beneath the embankment.

In accordance with the United States Fish and Wildlife Service's Biological Opinion (BO) dated May 22, 2001, the Port will provide protection for both aquatic resources and surface water quality in neighboring Miller and Walker Creeks by establishing a zone of "ultra-clean" fill directly above the drainage layer, referred to as the "drainage layer cover" (Figure 3). The soil criteria in this drainage layer cover is at Puget Sound background levels and adjusted as necessary for Practical Quantitation Limits, MTCA Method A cleanup levels, and or ecological criteria (Table 1, FWS BO, 2001). These criteria have been modified slightly in accordance with the release of the amended 401 Certification by Ecology in September, 2001.

The drainage layer cover will measure at least 40 feet thick at the face of the embankment and its top surface will slope downwards to the east at a rate of 2 percent. The overall thickness of the drainage layer cover will decrease away from the face of the embankment and will vary based on underlying topography (Figure 1). The southern section of the embankment south of S. 170th Street will be less than 40 feet high and will be composed primarily of "ultra clean" fill consistent with the requirements of the BO.

A portion of the rainfall that falls on the Third Runway embankment, plus some of the runoff from paved areas such as runways and taxiways, will infiltrate through the fill materials and percolate down to the drainage layer. As water percolates through the fill, the concentrations of dissolved constituents may potentially change due to leaching of naturally occurring minerals or other chemical constituents (if present) in the fill.

Depending on location, the water that flows through the completed embankment will (1) percolate down to the drainage layer and flow laterally to discharge from the embankment toe, or (2) percolate downward through the drainage layer and into the underlying subsoils, entering the existing body of shallow groundwater beneath the embankment (Figure 3).

The first of these flow paths may include a portion of groundwater seepage from below that will mix with the embankment seepage. The water will discharge from the drainage layer and enter collection swales or replacement drainage channels that generally run along or near to the toe of the embankment. In low areas near the MSE retaining walls, flow in the collection swales will discharge to downslope replacement drainage channels or downslope wetlands (Figure 2). Over the rest of the embankment area, flow in collection swales will be directed to stormwater detention ponds that control releases to Miller or Walker Creeks. The conveyance system is described in the Comprehensive Stormwater Management Plan (Parametrix, 2000).

The second flow path consists of embankment seepage that will percolate down through the drainage layer to the water table and mix with the natural groundwater. Along the existing slope, the uppermost water table occurs mainly in recessional or recent sands and silts that are perched on a lower-permeability layer (typically glacial till). When this water table is below the bottom of the drainage layer, water flows slowly through the perched aquifer under the embankment and discharges through or beneath wetlands to the adjacent creeks. Water percolating through the embankment that does not discharge from the drainage layer is expected to enter this zone of perched groundwater and follow the same flowpath toward the wetlands and creeks. A relatively small portion of the water in the perched aquifer leaks through the till layer and enters the regional aquifer in the underlying advance glacial deposits.

Towards or beyond the toe of the embankment (varying by location), the water table in the perched zone merges with the water table in the shallow regional aquifer (Figure 3), which flows slowly through the downslope subsoils to discharge as baseflow to the creeks. A portion of this subsurface flow helps to maintain high groundwater levels and sustain the hydrology of riparian wetlands adjacent to Miller Creek and at the headwaters of Walker Creek.

3.0 GROUNDWATER MONITORING DURING CONSTRUCTION

Groundwater monitoring during construction is expected to occur in two phases. The first phase, which will occur over the next year, will define background groundwater conditions by collection of a baseline groundwater data set. The baseline data set will be used as a reference to ascertain changes in groundwater quality as a result of embankment construction. This baseline groundwater data acquisition phase is discussed in Subsections 3.1 through 3.4. The second phase of groundwater monitoring, described in section 3.5, commences after baseline data acquisition is completed.

3.1 Baseline Groundwater Data Acquisition

Groundwater monitoring wells will be established at the toe of the future embankment (locations are described in Section 3.2). The groundwater monitoring schedule is described in Section 3.3. Monitoring data from these wells will be used to establish baseline water quality for each of the parameters listed in Section 3.4. Collected data will be evaluated and background data quality established by application of appropriate statistical methods, and will account for variability caused by seasonality or other spatial or temporal trends.

As construction of the Third Runway embankment proceeds, the baseline groundwater data set will be used to assess potential impacts to groundwater through the screening approach outlined in Section 3.5.

3.2 Groundwater Monitoring Locations

Groundwater monitoring will be conducted by taking samples from 15 shallow monitoring wells drilled in locations at or just downgradient from the toe of the future embankment (Figure 1). Locations have been selected to provide coverage of the embankment where seepage discharge is not expressed and, therefore, the majority of the flow through the embankment is entering groundwater. This approach will provide representative monitoring of groundwater quality in areas where the water table is expected to remain below the drainage layer. Wells will be completed in the uppermost zone of continuous saturation, which is generally the perched aquifer in the surficial recessional deposits. Details concerning the proposed monitoring wells are presented in Table 1.

Some of the proposed groundwater monitoring locations utilize existing wells that were installed as part of the geotechnical investigations for the design phase of the Third Runway embankment. These wells were installed as resource protection wells meeting the requirements of Chapter 173-160 WAC, and should therefore provide acceptable monitoring points. The remaining locations will require new well installations conforming to Chapter 173-160 WAC (Part Two). Following approval of this EFMP, wells will be installed to expedite the initiation of baseline groundwater data acquisition.

To the extent possible, monitoring wells will be maintained for sampling as construction proceeds. Any wells that cannot be successfully protected against damage during construction will be appropriately abandoned and replaced as close as practical to their original location.

3.3 Groundwater Monitoring Schedule

The groundwater monitoring wells will be sampled to establish a statistical baseline for existing groundwater quality. Background sampling will be implemented on a monthly basis (following well installation) for one year to define area baseline water quality.

Following the baseline data collection period, groundwater sampling will continue on a quarterly basis to track any changes or trends in the water quality at the site. Monitoring results will be screened to identify potentially significant exceedences using a staged screening approach, as described in Section 3.5.

3.4 Groundwater Monitoring Parameters

The following constituents of concern will be screened in groundwater and embankment seepage for consistency with the specific soil fill criteria requirements outlined in Section E.1(b) of the 401 Water Quality Certification:

Antimony	Nickel
Arsenic	Selenium
Beryllium	Silver
Cadmium	Thallium
Chromium (total)	Zinc
Copper	Gasoline
Lead	Diesel
Mercury (inorganic)	Heavy Oils.

See Appendix Sections A-C for a discussion on Sampling Methods and Handling Procedures, Quality Assurance and Quality Control Procedures, and Field Documentation, respectively.

3.5 Groundwater Quality Screening Post Baseline Data Acquisition

As described above, data collected from groundwater monitoring wells over the first year of monitoring will be used to determine the area background groundwater quality of the Third Runway vicinity. Appropriate background values will be calculated and will be referred to as the baseline groundwater data set.

After the baseline groundwater data set is established, quarterly groundwater monitoring data will be evaluated using a staged approach. The approach for groundwater screening during construction is detailed in the two stages as discussed below. Results that exceed any staged screening criteria do not directly equate to adverse impacts to wetlands or other waters of the state; rather, such exceedences provide an indication that further review and analysis are warranted to protect against the occurrence of such impacts.

- Stage 1: Background. Groundwater samples collected from each monitoring well will be analyzed for thirteen metals and Total Petroleum Hydrocarbons (TPH) and compared to the baseline groundwater data set described above. If Stage 1 screening indicates significantly elevated levels for constituents of concern, Ecology will be notified, and Stage 2 of the screening process would be implemented as described below.

- Stage 2: Derivation of a site-specific dilution/attenuation factor for groundwater. As constituents in the embankment seepage move through soils and groundwater, they are subjected to physical, chemical, and biological processes that tend to reduce the original concentration of the constituent as it is transported between the embankment and the receptor point (neighboring creeks). These processes include adsorption onto soil and aquifer media, chemical transformation, biological degradation, and dilution due to mixing of the seepage with surface waters and underlying groundwater. The reduction in constituent concentrations between the toe of the embankment and the creeks can be estimated by developing a site-specific dilution/attenuation factor, or using an Ecology-published default dilution/attenuation factor, as appropriate. The Port will discuss any proposed site-specific dilution factors with Ecology prior to their implementation.

The Port may elect to establish alternative sampling locations consistent with the tiered monitoring location strategy described generally in Section 1.0, and in more detail in Section 5.1, if it is determined that groundwater quality may be changing with respect to established background groundwater conditions. The Port may also elect to skip Stage 2 of the post-baseline groundwater monitoring screening process and move directly to Tier 2 sampling if it becomes evident that sampling at locations between the embankment toe and the creeks is a more appropriate approach. The Port will discuss a proposed move to Tier 2 with Ecology prior to implementation.

4.0 SEEPAGE MONITORING DURING CONSTRUCTION

Construction of the Third Runway embankment is expected to take 5 to 7 years under current projections. Construction will be accomplished in phases defined by phase-specific construction contracts. The duration of each construction phase is generally one construction season or one year, resulting in the creation of interim embankment slopes that are underlain by the drainage layer (see Figure 3). A portion of these interim embankment slopes will be relatively undisturbed for an extended temporary period , thereby facilitating seepage monitoring during construction.

4.1 Interim Seepage Monitoring Locations

Monitoring of the embankment fill seepage during construction will be achieved by selecting representative seepage locations for sampling as construction proceeds. Seepage monitoring locations will be selected, monitored, and abandoned or dismantled as the extent and shape of the Third Runway embankment changes during construction.

At the end of each construction phase, the location and extent of interim embankment slope surfaces that will remain unchanged for the duration of at least the next construction phase (at least one year) will be identified. Seeps from these interim slopes will be observed and documented during an initial three-month reconnaissance period to confirm the presence and continuity of seepage. Representative seeps will be identified, and monitoring locations will be selected, numbered, documented, and photographed, with location and elevation surveyed by the Port. Monitoring locations may be moved if it is determined that the seepage expression changes over time.

The procedure outlined above will permit the establishment of interim seepage monitoring locations that will be available for periods of 12 months or more. As construction phases progressively reach the final embankment configuration, post-construction seepage monitoring locations within each phase will be identified as described in Section 5.2, and post construction monitoring will commence as described in Section 5.0

4.2 Interim Seepage Monitoring Schedule

Once documented, the interim seepage monitoring points will be sampled on a monthly basis. Sampling at each interim seepage monitoring location will track any changes or trends in the water quality of the seeps selected until the location is no longer available due to the initiation of the next construction phase.

4.3 Seepage Monitoring Parameters

At each interim seepage monitoring location, the same constituents will be monitored as listed in Section 3.4

4.4 Interim Seepage Quality Screening

Data evaluation will be implemented progressively in three stages to determine if seepage quality at the interim seepage monitoring locations is of potential concern. Results that exceed any staged screening criteria do not directly equate to adverse impacts to wetlands or other waters of the state; rather, such exceedences provide an indication that further review and analysis are warranted to protect against the occurrence of such impacts.

The approach for seepage screening during construction is detailed in three stages as discussed below.

- Stage 1: Surface Water Quality Criteria. Samples of seepage collected from each selected interim monitoring location will be analyzed for thirteen metals and TPH and compared to applicable freshwater ambient water quality criteria according to guidelines outlined in WAC 173-201A-40. Values will be adjusted for the Practical Quantitation Limits when necessary (Table 3). The Port may elect to screen seepage against background surface water data collected from the neighboring creeks, but will notify Ecology prior to this screening modification.

  The constituent concentrations as determined from the interim monitoring will be divided by a dilution/attenuation factor of 10 and then compared to applicable ambient surface water quality criteria. This default dilution factor is presented in NOAA's Screening Quick Reference Tables and is based on the fact that dilution is expected to occur during migration and upon discharge of groundwater to surface water. The actual dilution/attenuation factor which would occur between the seepage at the interim monitoring location, to the adjacent surface water drainage systems, and then transport to the creeks is likely to be much greater, as discussed in Stage 2 below.

- Stage 2: Derivation of site-specific dilution/attenuation factor for seepage. As constituents in the embankment seepage occurring during construction move through surface water drainage systems or through soils and groundwater, they are subjected to physical, chemical, and biological processes that tend to reduce the original concentration of the constituent during transport between the embankment and the receptor point (associated creeks). These processes include adsorption onto soil and aquifer media, chemical transformation, biological degradation, and dilution due to mixing of the seepage with surface waters and underlying groundwater. The reduction in constituent concentrations between the interim seepage monitoring locations and the creeks can be predicted by developing a site-specific dilution/attenuation factor. As an alternative to the default dilution/attenuation factor discussed in Stage 1, the Port may elect to derive a site-specific dilution/attenuation factor for application to the interim seepage monitoring results per specifications outlined in WAC 173-340-747. The Port will discuss any proposed site-specific dilution/attenuation factors with Ecology prior to their implementation.

- Stage 3: Bioassay Testing for Seepage. If the Port determines that interim seepage samples are exceeding applicable surface water quality criteria, the Port may elect to conduct aquatic bioassays on seepage samples using Ecology-approved methods. There are many circumstances in which numerical water quality criteria are exceeded in a sample, but bioassay testing shows the sample to pass standard toxicity testing criteria. This is because many naturally-occurring constituents exist, such as particulate matter, organic carbon, and inorganic ligands, that render certain potential toxicants unavailable for uptake, and hence, nontoxic. If the Port elects to conduct bioassay testing, the Port will submit a proposed bioassay testing plan to Ecology for review prior to implementation. Bioassay test results would contribute to a weight-of-evidence evaluation on the probability of impact from embankment seepage during construction on water quality.

The Port may elect to establish alternative sampling locations consistent with the tiered monitoring location strategy described generally in Section 1.0, and in more detail in Section 5.1, if it is determined that embankment seepage may be exceeding applicable water quality criteria. The Port may also elect to skip Stages 2 and 3 of the interim seepage screening process and move directly to Tier 2 sampling if it becomes evident that sampling at locations between the embankment toe and the creeks is a more appropriate approach. The Port will discuss a proposed move to Tier 2 with Ecology prior to implementation.

5.0 POST CONSTRUCTION EMBANKMENT SEEPAGE AND GROUNDWATER MONITORING

As phased construction of the Third Runway Embankment reaches completion, monitoring of embankment seepage and groundwater will continue under a tiered post construction monitoring strategy that is protective of aquatic resources. Subsection 5.1 explains the three tiered location monitoring strategy approach. Subsection 5.2 discusses the Tier 1 monitoring locations for both seepage and groundwater. The monitoring schedule and constituents to be monitored are described in Subsections 5.3 and 5.4, respectively. Finally, the approach for evaluating and comparing analytical results to applicable water quality criteria within each tier is described for seepage in Subsection 5.5.1 and for groundwater in Subsection 5.5.2.

5.1 Post Construction Tiered Location Monitoring Strategy

Ecology's goal is to ensure that the use of imported fill will not result in adverse impacts to surface waters. To achieve this goal, the Port proposes a monitoring strategy that proceeds in a three "tiered" approach. Seepage and groundwater is first collected near the toe of the embankment where samples are most likely to be representative of water flowing through the embankment (Tier 1). However, if it is determined that monitored ground water exceeds established background conditions or seepage exceeds applicable water quality criteria, new sampling locations may be situated between the embankment and associated surfaces waters to demonstrate that attenuation and dilution mechanisms are occurring (Tier 2). The third tier would involve direct surface water sampling in the associated creeks. This three-tiered approach is discussed in more detail below.

- Tier 1. For seepage monitoring, Tier 1 utilizes a conservative procedure by collecting samples of water directly discharged along the toe of the final embankment without consideration of mixing or attenuation processes that occur between the embankment and the receiving waters. Drainage layer seepage is assumed to be representative of the water percolating through the embankment fill. Monitoring and evaluation of representative seepage locations will be performed as described below in Section 5.2. The methods to evaluate the data are described in Section 5.5.1.

  For groundwater, Tier 1 groundwater monitoring wells will be those used in the baseline study (Section 3.1). The staged approach to screening groundwater data will be implemented as described below in Section 5.5.2.

- Tier 2. If it is determined over time that seepage and/or groundwater is significantly exceeding all applicable stages of the screening criteria at the toe of the embankment, then Tier 2 monitoring will be conducted. Tier 2 will consist of installing new sampling locations between the embankment and associated creeks in order to ascertain the fate of the seepage and/or groundwater as it migrates from the embankment. The selection of monitoring points in surface water locations will depend on the observed nature of the flow regime (e.g., flow directions and flow rates). In the event that Tier 2 monitoring is determined to be necessary, an EFMP addendum describing the Tier 2 monitoring locations would be submitted to Ecology for its review and approval. The staged approach to screening data in Tier 2 will be the same as for Tier 1, as described in Section 5.5.

- Tier 3. If the results of Tier 2 monitoring significantly exceed the staged screening criteria, direct monitoring of surface waters in Miller and Walker Creeks would be implemented to demonstrate protection of aquatic biota. In this case, a monitoring program would be designed to implement the Tier 3 sampling strategy under a new Tier 3 EFMP to be submitted to Ecology for its review and approval.

5.2 Tier 1 Post Construction Monitoring Locations for Groundwater and Seepage

Groundwater sampling locations will be the same as used for the groundwater monitoring program as described in Section 3.2. These locations are considered Tier 1 locations since they are directly downgradient of the embankment.

The monitoring points for embankment seepage will be placed at selected locations where seepage consistently discharges from the drainage layer at the toe of the completed embankment. Since the elevation of the drainage layer will not be uniform, and will vary with existing topography, seeps are expected to occur mainly in topographic low spots along the toe of the embankment. Monitoring points will be selected based on the seepage flow rate, proximity to the adjacent creek, and locations of flow dispersal to wetlands.

Monitoring of the embankment fill seepage will be achieved by selecting representative seepage locations for sampling under Tier 1 as each phase of final embankment construction is completed and seeps are observed.. A review of current land surface topography beneath the proposed embankment fill area has been performed to identify locations where seepage is most likely to occur. Fifteen tentative locations are shown on Figure 2. A revised list of post construction seepage monitoring locations will be provided in a plan addendum issued following the completion of the Third Runway embankment, when the actual occurrence of seeps will be expressed. Monitoring locations will be numbered, documented, and photographed, with location and elevation surveyed by the Port. Monitoring locations may be moved if it is determined that the seepage expression changes over time or downstream hydraulic conditions change.

5.3 Post Construction Monitoring Schedule for Groundwater and Seepage

As discussed above, groundwater monitoring will occur on a quarterly basis during the construction of the embankment and remain on this same schedule once the embankment is completed. Ground water monitoring will be conducted for a period of eight years, including baseline, construction, and post-construction monitoring.

The post construction seepage monitoring period will commence, in different locations at different times, following the sequence in which final embankment construction contract phases are completed (see Section 4.1). While post construction monitoring is being conducted in completed portions of the embankment, interim seepage monitoring will continue to the extent possible in areas where construction of the final embankment is not complete.

Seepage monitoring will be performed monthly. It is possible that seeps may be dry from time to time on a seasonal or temporal basis. After one year of monthly post construction seepage monitoring, the Port may request that the monitoring interval for embankment seepage be extended to quarterly monitoring, if the data collected demonstrate that quarterly monitoring will be representative of seep constituent variability.

Seepage monitoring will be conducted for a total period of eight years, commencing upon the initiation of interim monitoring. At the end of the eight-year ground water and seepage monitoring periods, the Port and Ecology will re-evaluate the need to modify or continue the monitoring program.

5.4 Monitoring Parameters for Groundwater and Seepage

Thirteen metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury [inorganic], nickel, selenium, silver, thallium, and zinc), TPH, etc., will be analyzed for both groundwater and seepage in the same manner as previously described for the groundwater monitoring program in Section 3.4.

See Appendix Sections A-C for a discussion on Sampling Methods and Handling Procedures, Quality Assurance and Quality Control Procedures, and Field Documentation, respectively.

5.5 Tier 1 Staged Water Quality Screening

Sample analytical results from seepage and groundwater will be evaluated using a staged approach. This progressively rigorous evaluation will be used if seepage or groundwater quality at the embankment toe is determined to be of potential concern. Results that exceed the staged screening criteria applied in Tier 1 do not directly equate to impacts to wetlands or other waters of the state. Rather, such exceedances provide an indication that further review and progressive analysis is warranted.

5.5.1 Seepage Staged Screening. The staged approach for seepage screening is detailed in three stages as discussed below.

- Stage 1: Surface Water Quality Criteria. Samples of seepage collected from each selected location will be analyzed for thirteen metals and TPH and compared to applicable freshwater ambient water quality criteria according to guidelines outlined in WAC 173-201A-40. Values will be adjusted for the Practical Quantitation Limits when necessary (Table 3). The Port may elect to screen seepage against background surface water data collected from the neighboring creeks, but will notify Ecology of this screening modification.

  The constituent concentrations as determined from the Tier 1 monitoring will be divided by a dilution/attenuation factor of 10 and then compared to applicable ambient surface water quality criteria. This default dilution factor is presented in NOAA's Screening Quick Reference Tables and is based on the fact that dilution is expected to occur during migration and upon discharge of groundwater to surface water. The actual dilution/attenuation factor which would occur between the seepage at the toe of the embankment to the adjacent surface water drainage systems and then transport to the creeks is likely to be much greater, as discussed in Stage 2 below.

- Stage 2: Derivation of site-specific dilution/attenuation factor for seepage. As constituents in the embankment seepage move through surface water drainage systems or through soils and groundwater, they are subjected to physical, chemical, and biological processes that tend to reduce the original concentration of the constituent as it is transported between the embankment and the receptor point (associated creeks). These processes include adsorption onto soil and aquifer media, chemical transformation, biological degradation, and dilution due to mixing of the seepage with surface waters and underlying groundwater. The reduction in constituent concentrations between the toe of the embankment and the creeks can be predicted by developing a site-specific dilution/attenuation factor. As an alternative to the default dilution/attenuation factor discussed in Stage 1, the Port may elect to derive a site-specific dilution/attenuation factor for application to the embankment seepage monitoring results per specifications outlined in WAC 173-340-747. The Port will discuss any proposed site-specific dilution/attenuation factors with Ecology prior to their implementation.

- Stage 3: Bioassay Testing for Seepage. If the Port determines that Tier 1 seepage samples are exceeding applicable surface water quality criteria, the Port may elect to conduct aquatic bioassays on seepage samples using Ecology-approved methods. There are many circumstances in which numerical water quality criteria are exceeded in a sample, but bioassay testing shows the sample to pass standard toxicity testing criteria. This is because many naturally-occurring constituents exist, such as particulate matter, organic carbon, and inorganic ligands, that render certain potential toxicants unavailable for uptake, and hence, nontoxic. If the Port elects to conduct bioassay testing, the Port will submit a proposed bioassay testing plan to Ecology for review prior to implementation. Bioassay test results would contribute to a weight-of-evidence evaluation on the probability of impact from embankment seepage on water quality.

The Port may elect to skip Stages 2 and 3 of the Tier 1 surface water quality screening process and move directly to Tier 2 sampling if it becomes evident that sampling at locations between the embankment toe and the creeks is a more appropriate approach. The Port will discuss a proposed move to Tier 2 with Ecology prior to implementation.

5.5.2 Groundwater Staged Screening

The approach for groundwater screening after construction of the Third Runway Embankment is detailed in three stages as discussed below.

- Stage 1: Background. Groundwater samples collected from each monitoring well will be analyzed for thirteen metals and Total Petroleum Hydrocarbons (TPH) and compared to the baseline groundwater data set. If Stage 1 screening indicates significantly elevated levels for constituents of concern, the Port will notify Ecology, and Stage 2 of the screening process will be implemented as described below.

- Stage 2: Derivation of a site-specific dilution/attenuation factor for groundwater. As constituents in the embankment seepage move through soils and groundwater, they are subjected to physical, chemical, and biological processes that tend to reduce the original concentration of the constituent as it is transported between the embankment and the receptor point (neighboring creeks). These processes include adsorption onto soil and aquifer media, chemical transformation, biological degradation, and dilution due to mixing of the seepage with surface waters and underlying groundwater. The reduction in constituent concentrations between the toe of the embankment and the creeks can be estimated by developing a site-specific dilution/attenuation factor, or using an Ecology-published default dilution/attenuation factor, as appropriate. The Port will discuss any proposed site-specific dilution/attenuation factors with Ecology prior to their implementation. If Stage 2 screening indicates that significantly elevated levels for constituents of concern threaten to impact the quality of waters of the state, Ecology will be notified, and Stage 3 of the screening process would be implemented as described below.

- Stage 3: Fate and Transport Groundwater Flow Modeling. Stage 3 will utilize groundwater modeling to provide a more detailed representation of groundwater flowpaths and attenuation processes in the area within and downgradient of the embankment fill. A groundwater flow model would be established to take account of the design, structure and hydrologic properties of the as-built embankment and represent the fate and transport of specific constituents of concern through the shallow aquifers, discharging to the adjacent creeks and through riparian wetlands. The Port will discuss and agree to protocols for any proposed groundwater flow, fate and transport modeling with Ecology prior to its implementation.

6.0 MONITORING REPORT

A groundwater and seepage monitoring report will be produced annually after acquisition of the associated laboratory analytical results. The first report is scheduled for completion within 15 months of the first background groundwater sampling round. The annual report will contain both groundwater and seepage evaluations, and will include the following: (1) a data quality review, findings, and recommendations; (2) a site map showing relevant features, sampling locations, and a description of field activities; and (3) tables summarizing the analytical results. Ecology will be notified if applicable water quality criteria are exceeded as described above.

7.0 CONTINGENCY PLAN

Condition E.3 of the Water Quality Certification for U.S. Army Corps of Engineers Public Notice 1996-4-02325 (Amended-1), states: "*In the event monitoring detects exceedances of the water quality criteria in either surface or groundwater, Ecology may revise the fill criteria and/or require corrective action.*" The Port will implement the required monitoring as described above, and will notify Ecology as directed.

REFERENCES

Ecology, 2001. Water Quality Certification for U.S. Army Corps of Engineers Public Notice 1996-4-02325 (Amended-1). September 21, 2001.

Ecology, 2001, Model Toxics Control Act Cleanup Regulation. WAC 173-340. Publication 94-06.

EPA, 1996. Test methods for Evaluating Solid Waste Physical/Chemical Methods EPA SW-846, Third Revision.

NOAA 1999. Screening Quick Reference Tables.

Parametrix, 2001. Comprehensive Stormwater Management Plan, Master Plan Update Improvements, Seattle-Tacoma International Airport. July 2001.

Port of Seattle. NPDES Permit No. WA-02465-1. Port of Seattle, Seattle-Tacoma International Airport. May 29, 2001.

Port of Seattle. Procedures Manual for Stormwater Monitoring. Seattle-Tacoma International Airport, Seattle, WA. Revision 6. April 22, 1999.

USFWS, 2001. Biological Opinion. Master Plan Update Endangered Species Act Consultation, Seattle Tacoma International Airport, Ref # 1-3-00-F-1420.

WAC 173-160 Minimum Standards for Construction and Maintenance of Wells.

WAC 173-201A Water Quality Standards for Surface Waters of the State of Washington.

EXHIBIT 1

Exhibit 1 – Text of Post Construction Monitoring

From the Water Quality Certification for the U.S. Army Corps of Engineers Public Notice 1996-3-02325, E. Conditions for Acceptance of Fill to be used in Construction of Port 404 Projects, 3. Post Construction Monitoring

> "The Port shall monitor runoff and seepage from Port 404 Projects where fill is placed for compliance with applicable Washington State surface water criteria. Groundwater down-gradient from the fill area shall be monitored for compliance with applicable groundwater criteria.

Within 60 days after the issuance of the 401 Water Quality Certification for the Master Plan Update Improvements, the Port shall submit to Ecology for review and written approval a Surface Water and Groundwater Monitoring Plan. The monitoring plan shall be designed to detect impacts of the fill embankment to the receiving water and to the groundwater during fill placement and post fill placement. In the event monitoring detects exceedances of the water quality criteria in either surface or groundwater; Ecology may revise the fill criteria and/or require corrective action."

TABLES

Table 1 – Groundwater Monitoring Wells (Proposed)

Provisional Well ID	Approximate Coordinates	Elevation in feet above mean sea level	Estimated Perched Groundwater Level	Well Depth in feet below ground surface	Screen Length in Feet
MW-1	N 22050 E 11270	~275	~270	15	10
MW-2	N 21900 E 10792	~265	~265	12	10
MW-3	N 21365 E 10602	~265	~265	12	10
MW-4	N 20390 E 10675	~290	~280	20	10
MW-5	N 19490 E 10630	~265	~260	15	10
MW-6	N 18902 E 10588	~250	~240	20	10
MW-7	N 18480 E 10615	~230	~230	12	10
MW-8	N 18135 E 10815	~230	~230	12	10
MW-9	N 17645 E 10780	~250	~240	20	10
MW-10	N 16970 E 10848	~340	~320	35	20
MW-11	N 16212 E 10875	~360	~340	40	20
MW-12	N 15512 E 10950	~360	~340	40	20
MW-13	N 14812 E 10905	~335	~320	25	10
MW-14	N 14420 E 10900	~300	~295	15	10
MW-15	N 14005 E 10912	~310	~300	20	10

Notes: As-built well depths, elevations, and coordinates will be surveyed and provided following well drilling and installation.

Table 2 – Post-Construction Drainage Layer Seepage Monitoring Points (Tentative)

Provisional Drainage Layer Seep ID	Approximate Coordinates	Elevation in feet above mean sea level	Approximate Location
DS-1	N 22052 E 11500	~277	North Safety Area: beneath eastern part of North MSE Wall
DS-2	N 22030 E 10995	~270	North Safety Area: beneath North MSE Wall
DS-3	N 21595 E 10630	~263	North Safety Area: above Miller Creek realignment
DS-4	N 20908 E 10740	~279	North of Pond C, below 120-ft high embankment slope
DS-5	N 19942 E 10730	~276	North of Pond G, below 120-ft high embankment slope
DS-6	N 19098 E 10580	~246	South of Pond G, below 2:1 embankment slope
DS-7	N 18705 E 10565	~232	Below embankment toward northern end of West MSE Wall
DS-8	N 18342 E 10710	~227	Below northern part of West MSE Wall
DS-9	N 17878 E 10845	~225	Below central part of West MSE Wall
DS-10	N 17360 E 10762	~285	Below southern part of West MSE Wall
DS-11	N 16510 E 10922	~352	North of Pond G, below 25-ft high embankment slope
DS-12	N 16090 E 10945	~362	South of Pond G, below 10-ft high embankment slope
DS-13	N 14992 E 10930	~345	North of South MSE Wall, below 18-ft high embankment
DS-14	N 14560 E 10920	~290	Below northern part of South MSE Wall
DS-15	N 14195 E 10918	~283	Below southern part of South MSE Wall

<u>Notes:</u> Drainage Layer Seeps will be selected for sampling based on occurrence of seepage flows. Final coordinates and elevations will be surveyed and provided following completion of the Third Runway Embankment.

Table 3 – Methods of Analysis, Screening Criteria, and Reporting Limits

Analyte	State FW Chronic[1]	State FW Acute[1]	Lab Reporting Limit Goal	Analytical Method
Hardness in mg/L			0.2	EPA Method 6010
Alkalinity in mg/L			10	EPA Method 310.1
Total Organic Carbon in mg/L			1	EPA Method 415.1
Dissolved Organic Carbon in mg/L			1	EPA Method 415.1
Total Suspended Solids in mg/L			5	EPA Method 160.1
Dissolved Metals in µg/L				
Antimony	NA	NA	1	EPA Method 6020
Arsenic	190	360	1	EPA Method 6020
Beryllium	NA	NA	1	EPA Method 6020
Cadmium*	0.62	1.75	0.5	EPA Method 6020
Chromium (total)	10	15	1	EPA Method 6020
Copper*	6.28	8.86	1	EPA Method 6020
Lead*	1.17	30	0.5	EPA Method 6020
Mercury	0.012	2.1	0.1	EPA Method 7470
Nickel*	87	787	1	EPA Method 6020
Selenium	5	20	3	EPA Method 6020
Silver*	NA	1.05	0.5	EPA Method 6020
Thallium	NA	NA	1	EPA Method 6020
Zinc*	58	64	4	EPA Method 6020
Total Petroleum Hydrocarbons in mg/L				
Gasoline			0.2	NWTPH-G
Diesel and Heavy Oils			0.5	NWTPH-Dx

Notes:

* - Surface Water criteria are dependent on hardness assume hardness of 50 mg/L

(1) WAC 173-201A Water Quality Standards for Surface Waters of the State of Washington

Table 4 - Sample Containers, Preservative, and Holding Times

Chemical Analysis	Sample Container	Preservative [1]	Holding Time
Dissolved Metals & Hardness	1 L P	HNO_3	28/180 days [2]
Alkalinity	1 L P	None; no head space	14 days
Total Organic Carbon	250 mL AG	H_2SO_4	28 days
Dissolved Organic Carbon	250 mL AG	H_2SO_4	28 days
TPH – Gasoline	3 x 40 mL vials	HCl	14 days
TPH – Extended Diesel	1 L AG	HCl	14 days

Sample Containers: P – Plastic; AG - Amber glass

Notes:
(1) All samples shall be maintained at 4°C.
(2) Holding time for mercury/remaining metals

FIGURES

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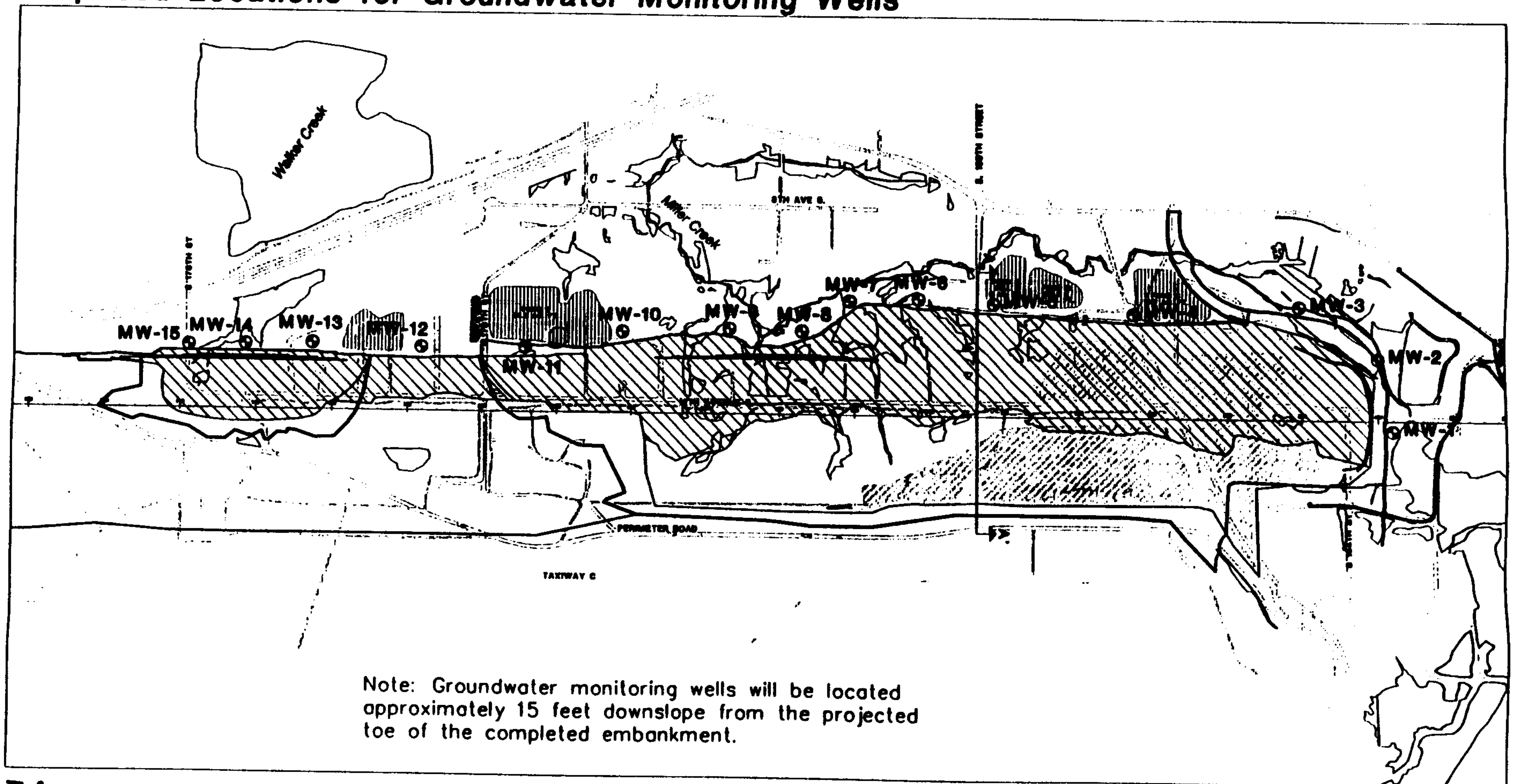
Third Runway - Embankment Seepage

Proposed Locations for Groundwater Monitoring Wells



- Drainage Layer Cover
- Existing Embankment Fill
- Maximum Extent of Drainage Layer
- Wetlands
- Stormwater Pond
- AA' Cross Section Location and Designation (See Figure 3)
- MW-7 Proposed Monitoring Well Location and Number

N

0 1000 2000
Scale in Feet

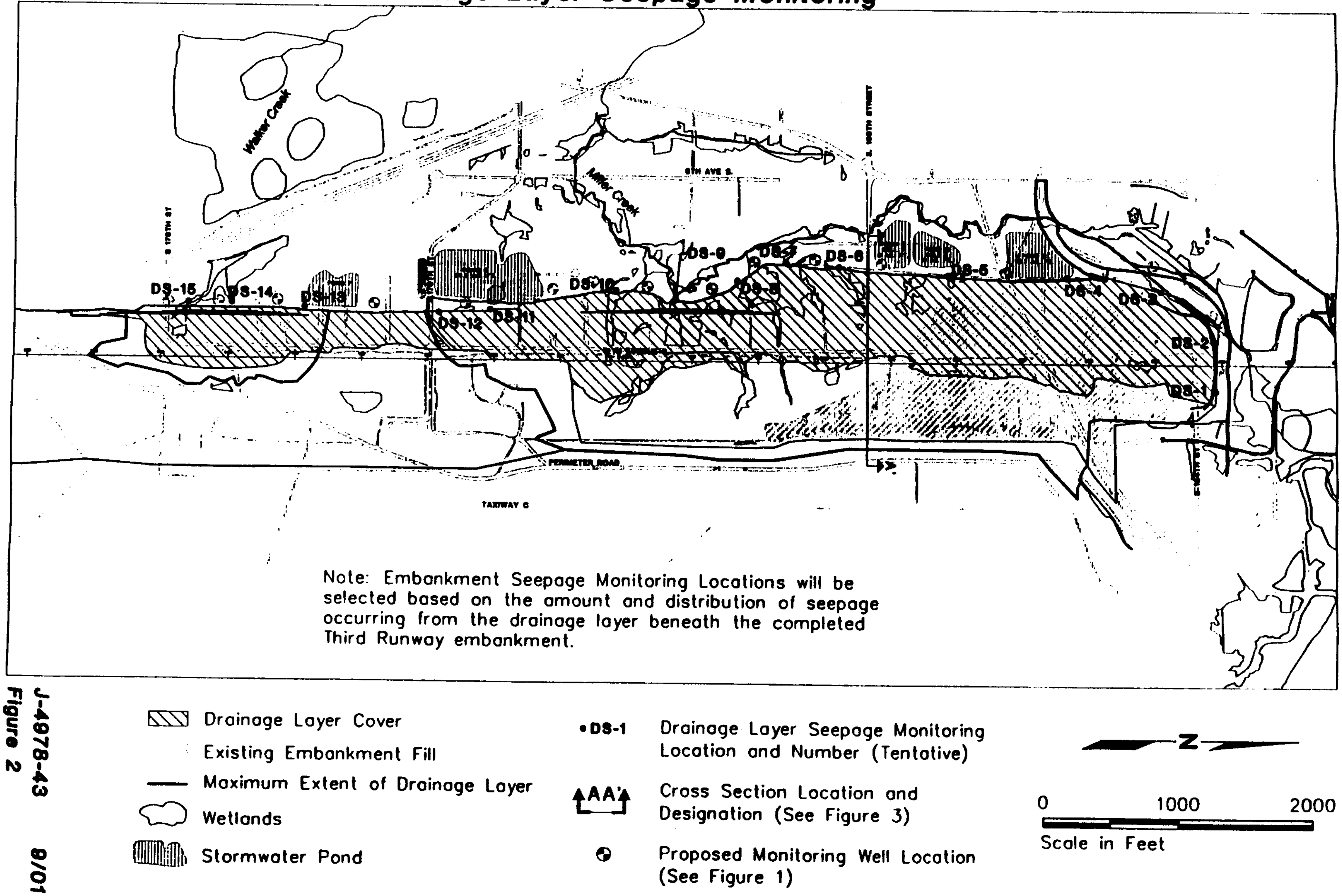
J-4978-43 9/01
Figure 1

AR 052444

DTN 10/18/01 1=1 charlie-8.pc2 49784311

Third Runway - Embankment Seepage

Tentative Locations for Drainage Layer Seepage Monitoring



J-4978-43 9/01

Figure 2

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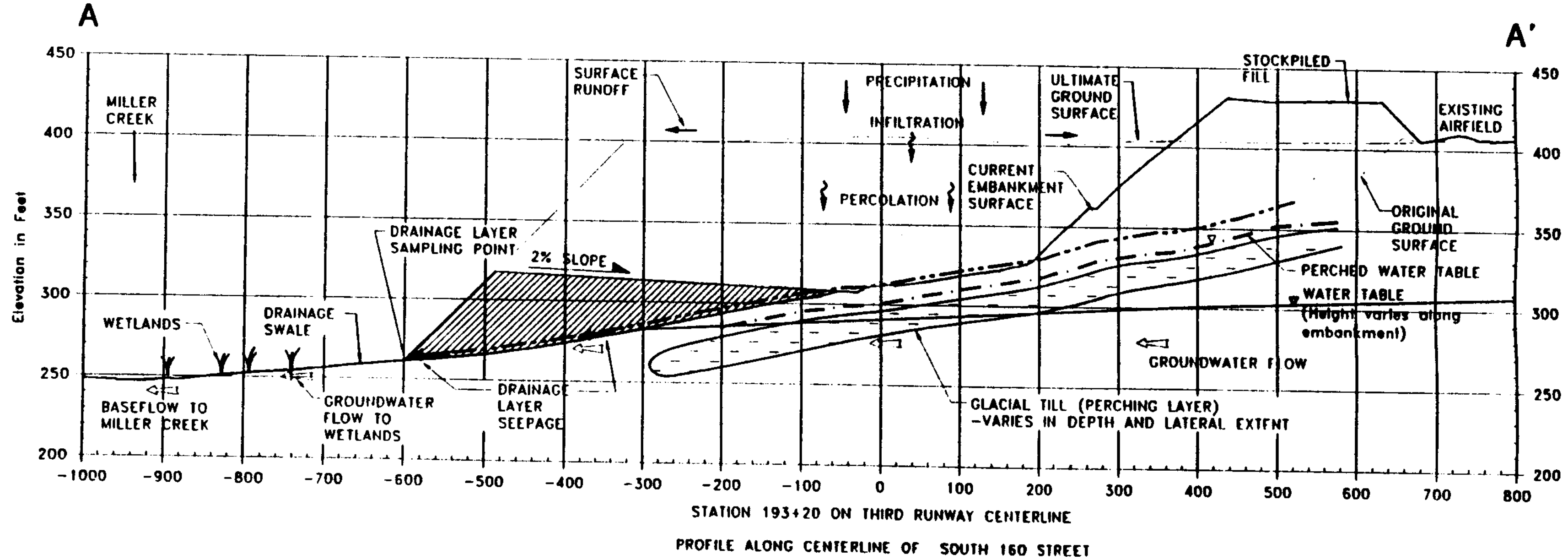
DTN 11/7/01 1=1 charlie pc2 49784309

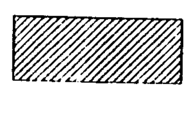
Third Runway - Embankment Seepage

Cross Section A-A' - Conceptual Site Flow Model



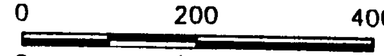
Note: The conceptual model is a schematic representaation of flow paths at a typical cross-section through the Third Runway embankment. Conditions, dimensions, elevations, and details vary along the length of the embankment.

LEGEND:



Drainage Layer Cover

Drainage Layer



J-4978-43 9/01
Figure 3

AR 052446

APPENDIX

APPENDIX: MONITORING PROCEDURES

A. SAMPLING METHODS AND HANDLING PROCEDURES

A.1 Groundwater Sampling.
To minimize turbidity, low-flow purging methods will be employed using a peristaltic pump system or dedicated bladder pumps to collect groundwater samples from monitoring wells. Typical flow rates range from 0.1 to 0.5 L/min, however, the flow rates utilized to purge the selected monitoring wells will be determined in the field by monitoring the water levels in each of the wells during sampling so that drawdown in the well is minimized. The general low-flow purging procedures are as listed below:

1. Measure static water level in well;
2. Turn pump on to initiate the pumping cycle and to clear any air in the discharge line;
3. Connect pump discharge tubing to the calibrated flow-through cell equipment;
4. Monitor drawdown in the well. The goal is to pump at a rate that produces minimal drawdown (e.g., typically less than 4 inches);
5. Measure the flow rate with a calibrated container (e.g., graduated cylinder); and
6. Continuously monitor in-line field parameters (listed below) during purging. Stabilization is achieved after all field parameters have stabilized for three consecutive readings. Three successive readings should be within 0.1 pH units for pH, and 10 percent for temperature, redox, and dissolved oxygen (EPA 1996).

Following stabilization, and prior to sample collection, the tubing will be disconnected from the flow-through cell. Groundwater samples will then be collected by directly filling pre-cleaned sample containers (Table 4). Dissolved organic carbon and metals samples will be collected by filtering with a 0.45 μm in-line filter. In addition, one field duplicate per sampling event will also be collected. Field observations and flow rates will be recorded on the groundwater sampling data sheet (Attachment 1).

The following field parameters will be measured prior to sample collection using appropriate field instrumentation and collection vessels.

Water level;	Temperature;
pH;	Redox Potential;
Electrical Conductivity;	Dissolved Oxygen

A.2 Sampling Methods for Embankment Seepage.
Sample collection may be aided by installing pipes to collect drainage from certain seeps. Appropriate methods will be used to estimate discharge rates. Samples will be collected using clean sampling techniques appropriately adapted from EPA 1669 methods. Field parameters will be measured prior to sample collection using appropriate field instrumentation and collection vessels. In addition, one field duplicate per sampling event will be collected. Field observations and seepage flow rates will be recorded on a seepage sampling data sheet (Attachment 1).

The following field parameters will be measured prior to sample collection using appropriate field instrumentation and collection vessels.

Water level;	Temperature;
pH;	Redox Potential;
Electrical Conductivity;	Dissolved Oxygen

A.3 Sample Labeling and Nomenclature. Sample labels will clearly indicate the sample number, date, sampler's initials, parameters to be analyzed, preservative added (if any), and any pertinent comments. Sample nomenclature will consist of the sample type (SW; ES, or GW, for surface water, embankment seepage, or groundwater, respectively), and the sampling point / Well ID number (e.g., DS-1; MW-1). The blind field duplicate will be labeled with the same sample type designation as the original sample, followed by -DUP (e.g., GW-DUP).

A.4 Chain of Custody Records. Chain of custody procedures will be employed to maintain and document sample possession. A sample is considered under a person's custody if it is in that person's physical possession, within visual sight of that person after taking physical possession, secured by that person so that the sample cannot be tampered with, or secured by that person in an area that is restricted to authorized personnel only.

Custody records completed by the sampler will accompany all shipments of samples. Each cooler will have a custody form (Attachment 2) listing the samples in the cooler. The purpose of these forms is to document the transfer of a group of samples traveling together; when the group of samples changes, a new custody record is initiated. The original custody record always travels with the samples; the initiator of the record keeps a copy.

The following procedures will be followed when using chain of custody record form(s):

1. The originator will fill in all requested information from the sample labels;
2. The person receiving custody will check the sample label information against the custody form. The person receiving custody will also check sample condition and note anything unusual under "Remarks" on the custody form;
3. The originator will sign the "Relinquished by" box and keep a copy of the custody form;
4. After delivery by a commercial carrier, the person receiving custody will sign in the "Received by" box adjacent to the "Relinquished by" box (may also be filled in by recipient as "Federal Express" or other carrier name). All signatures and entries will be dated;
5. When custody is transferred to the analytical laboratory, blank signature spaces may be left and the last "Received by" signature box used. Another approach is to run a line through the unused signature boxes;
6. In all cases, documentation shall establish that the same person receiving custody has relinquished it to the next custodian; and
7. If samples are left unattended or a person refuses to sign, this will be documented and explained on the custody form.

A.5 Sample Handling. Once collected, samples will be placed with the chain of custody form(s) in coolers for shipment to the analytical laboratory. Ice will be placed in each cooler to maintain a temperature of 4° C to meet sample preservation requirements. All samples will be delivered to the laboratory within 24 hours of collection. The following are general packaging procedures:

1. Sample labels with adhesive backing will be securely attached to each sample container;
2. Labeled sample containers will then be sealed into plastic bubble-wrap bags or Ziploc-type bags prior to being loaded into the sample coolers;
3. Insulated plastic coolers will be used as shipping containers. The drain plugs shall be taped shut (using strapping tape) on the inside and outside. Several plastic bubble-wrap sheets shall be placed on the interior bottom and sides of the coolers for shock absorption. One to three inches of Styrofoam pellet packing material may also be placed in the bottom of the coolers for additional shock absorption at the discretion of the Sampling Team Site Manager;
4. Styrofoam pellets may also be placed between sample containers to protect the containers from breakage during shipment and handling;
5. All samples requiring refrigeration will be chilled to 4° C with the addition of four bags (gallon-size Ziploc type - double bagged) of blue, cube, or block ice;
6. The paperwork intended for the laboratory will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The original custody form(s) will be included in the paperwork sent to the laboratory. If samples are sent by air transport, the air bill will be completed before the samples are handed over to the carrier;
7. Two signed custody seals will be placed over the lid of the cooler, one on the right front and one on the upper left, and covered with clear plastic tape;
8. The cooler will be securely taped shut with strapping tape wrapped completely around the cooler at least once in a minimum of two locations.
9. "Up Arrow" symbols will be placed on all four sides of cooler; and
10. The completed shipping label will be attached to the top of the cooler. The cooler will then be delivered to the overnight courier, or direct to the laboratory.

A.6 Sample Analysis Methods

The groundwater samples and field duplicates will be submitted to an analytical laboratory accredited by the WDOE for analysis under the following prescribed analytical methodologies: Dissolved Metals (Sb, As, Be, Cd, Cr, Cu, Pb, Ni, Se, Ag, Tl, Zn; EPA Method 6020; Hg: EPA Method 7470); Total Petroleum Hydrocarbons (NW-TPH-G and NW-TPH-Dx); Hardness (EPA Method 6010); Alkalinity (EPA Method 160.1); Total Suspended Soils (EPA Method 310.1); and Total and Dissolved Organic Carbon (EPA Method 415.1).

Details of analytical methods and recommended reporting limits are presented in Table 3. Sample preservation and holding time requirements are presented in Table 4. To maintain laboratory comparability, the same analytical laboratory will be used for the analysis of all seepage sampling events to the extent possible. Analytical methods will be utilized and/or modified as necessary to appropriately measure constituents relative to the screening criteria.

B. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Quality assurance/quality control procedures provide the means of controlling the precision and bias of the results. Adherence to established procedures for sample collection, preservation, and storage will minimize errors resulting from sampling and sample instability. Analytical and measurement systems must be in statistical control, which means that errors have been reduced to acceptable levels and then documented.

B.1 Field Quality Control Procedures

Field quality control procedures will include the collection of field duplicate samples and field equipment blanks.

Field Duplicates Field duplicates will be collected at a minimum of 5 percent per chemistry analytical method performed. Field duplicate relative percent differences (RPDs) will be less than 50 percent.
Filter Blanks. Filter blanks will be taken as a minimum rate of 5 percent of samples by running deionized water through the disposable filter apparatus and analyzing for all lab parameters.
Equipment Blanks. Equipment blanks will not be required since dedicated pipes, and /or pumps and tubing will be used to collect each sample.

B.2 Laboratory Quality Control Procedures

The laboratory quality control procedures used for this project will include: instrument calibration and standards as defined by EPA; laboratory blank measurements; and accuracy and precision measurements including laboratory control samples, matrix spikes, and duplicate analyses.
The laboratory quality control officer is responsible for assuring that the laboratory implements all routine internal quality assurance and quality control procedures. The laboratory quality control procedures used for this project will consist of the following, at a minimum:

1. Instrument calibration and standards as defined in EPA SW-846 (EPA 1996);
2. Laboratory blank measurements at a minimum frequency of 1 per 20 samples; and
3. Accuracy and precision measurements including laboratory control sample (LCS), matrix spike and duplicate analysis, at a minimum frequency of 1 per 20 samples. LCS and matrix spike recoveries shall be between 75 and 125 percent. Laboratory duplicate RPDs will be less than 20 percent.

C. FIELD DOCUMENTATION

All field documentation will be completed using indelible ink. A bound Field Notebook with consecutively numbered pages will be maintained by the sampling team to provide a daily record of significant events, observations, and measurements taken during the field investigation. The field notebook is intended to provide sufficient data and observations to enable the field team to reconstruct events that occur during the project and will contain the following as a minimum:

1. Date and time of sample collection;
2. Persons present in sampling team;
3. Weather conditions, including temperature;
4. The location name and project number;
5. Location of sampling point;
6. Sample identification number;
7. Type of sample;
8. Any field measurement taken;
9. Field observations;
10. References, such as maps or photographs of the sampling site; and
11. Any procedural steps taken that deviate from those outlined in this sampling plan.

Field parameters, observations, well or sampling point condition, and flow rates will also be recorded for each well or sampling point on the sampling data form (Attachment 1).

REPORT FORM

Groundwater Sampling Data - Well I.D. ____________________

Project ____________________ Date/Time Sampled ____________________

Job No. ____________________ Tidally Influenced Yes ___ No ___

Project Manager ____________________ Well Depth in Feet ____________________

Field Reps. ____________________ Screened Interval in Feet ____________________

① ***Purging Data/Field Measurements: All Measurements Relative to Top of Casing (TOC)***

Well Depth ____________________ Casing Volume in Gallons ____________________

Depth of Sediment (DTS) in Feet ____________________ [2" diameter = x .163 gal/ft 4" diameter = x .653 gal/ft]

Depth of Water (DTW) in Feet ____________________ Purge Volume in Gallons ____________________

(DTS - DTW) ____________________ Actual Purge in Gallons ____________________

	Time	No. of Gallons Purged	pH	Temp in °C	Conduct in ___	Diss. Oxygen in ___	Turbidity	Comments: Quality, Recovery, Color, Odor, Sheen, Accumulated Silt/Sand
Sample								

Comments ____________________

	Method	Pumping Rate in GPM	Depth of Equipment in Feet
Purge			
Sample			

Bails dry? Yes ___ No ___

At no. of Casing Volumes ____________________

Purge Water Disposal Method/Volume ____________________

② ***Sampling Data***

Bottle Type	No. of Containers	Analyses	Perserv.	Filter

Total Number of Bottles ____________________

Duplicate Sample I.D. ____________________

Field Blank I.D. ____________________

Rinseate Sample I.D. ____________________

③ ***Field Equipment***

Pump Type/Tubing Type ____________________

Bailer Type ____________________

Filter Type ____________________

Type/Brand/Serial No./Material/Units

Temp/pH/E.C. Meter ____________________

Water Level Probe ____________________

Other ____________________

④ ***Well Conditions*** OK ☐ Not OK ☐ Explain ____________________

HC Standards\Report Figures\Groundwater Well ID2

AR 052454