Draft 1997 Environmental Quality Monitoring Plan

for

Smith-Bybee Lakes Wildlife Area Including St. Johns Landfill

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Acknowledgements

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External review was provided by the following individuals: Scott Wells of Portland State University (Surface Water Monitoring); Bill Fish of the Oregon Graduate Institute (Sediment Monitoring); and Louis Caruso of Emcon Inc. (Groundwater Monitoring).

References used in developing the plan are cited within the text where applicable.

Environmental Quality Monitoring Plan Overview

Background

Metro Regional Environmental Management (REM) has prepared this environmental monitoring plan for the Smith-Bybee Lakes Wildlife Area (SBWA) in North Portland. SBWA is a 2,000 acre wetland -- one of the largest protected urban wetlands in the United States -- and is managed by Metro Regional Parks and Greenspaces. It is a remnant of a vast interconnected network of lakes, sloughs and marshes in the floodplain at the confluence of the Columbia and Willamette Rivers.

SBWA includes St. Johns Landfill (SJLF), a closed municipal solid waste landfill managed by REM. SJLF is a 240-acre, 60 year old site which was operated by the City of Portland until 1980. It served as the primary municipal waste disposal site for the Portland metropolitan area during the 1980's. Metro stopped accepted non-inert waste at the site in 1991, and currently accepts no waste.

Disposal of waste at SJLF preceded the stringent environmental regulations of today for municipal solid waste landfill operations. As a result, a variety of waste materials were disposed in the landfill over the years, including hazardous wastes. In addition, waste was not contained by an engineered structure designed to prevent contact with the surrounding environment.

Metro's objective is to close the St. Johns Landfill using cost effective methods to responsibly manage short and long term negative impacts on health, safety, and the environment, expecially within SBWA. In 1996 Metro completed a cover system over the landfill designed to prevent future formaton of leachate -- rainwater that has moved through the solid waste carrying contaminants into surrounding groundwater. Metro will continue to monitor conditions within SBWA to assess if and how much contaminated groundwater from SJLF contributes to environmental problems in SBWA, and to forecast when future problems could occur. This information will assist in the development of appropriate management strategies.

Regulatory Environment

Several regulatory mechanisms provide direction for environmental monitoring within SBWA. These mechanisms include State of Oregon environmental quality rules, various permits related to the closure and post-closure operations and maintenance of SJLF, and the Smith-Bybee Lakes Natural Resources Management Plan.

In 1995 DEQ added SJLF to two lists of sites which are subjected to the Oregon Environmental Cleanup Law through the Hazardous Substance Remedial Action Rules. One list includes sites in Oregon with confirmed releases of hazardous substances (Confirmed Release list); the other includes an inventory of sites in various phases of investigation and remediation (Inventory). The basis for these listings was the detection of substances of potential concern in leachate contained in the confines of the solid waste or in nearby groundwater.

In 1996, DEQ informed Metro that staff of DEQ's Solid Waste Section would enforce DEQ rules through its closure permit for SJLF. However, the future regulatory framework for SJLF would be rules of DEQ's Environmental Cleanup Division (ECD).

The Smith-Bybee Lakes Natural Resources Management Plan was approved in 1990 by the Portland Planning Commission, Portland City Council, Port of Portland, and Metro Council. It defines Metro's role in managing the SBWA, including goals for environmental quality monitoring (listed below) designed to ensure environmental values and uses established by the Plan.

- Maintain and enhance water quality in the lakes.
- Implement a monitoring program to assure early detection of potential environmental problems, and to quantify management programs.
- The major components of Metro's ongoing role should be programs and projects designed to protect the environment from unwanted impacts of SJLF. A logical extension of this role is monitoring programs and enhancement projects for the entire SBWA. This includes roles of both REM and Regional Parks and Greenspaces.
- A water quality monitoring program should be implemented that is specific to SBWA, including data collection related to development in the Rivergate Industrial Park, existing industries in the Suttle Road area, and other potential point and non-point sources.

Plan Components and Functions

While leachate formation is now being prevented at SJLF, existing leachate continues to pose a potential problem. Some leachate has contaminated groundwater at SJLF, and in some areas of the landfill has seeped through the perimeter dike into surrounding surface waters of the Columbia Slough and Smith and Bybee Lakes. A primary function of the plan is to assess impacts of leachate on the surrounding environment, including distinguishing those impacts from impacts caused by other sources, where possible. To do this, ongoing monitoring of several environmental media will be conducted. Each of these media represents a separate component of the plan, including:

- Groundwater Quality Monitoring (SJLF)
- Surface Water Quality Monitoring (SBWA)

- Sediment Quality Monitoring (SBWA)
- Stormwater Quality Monitoring (SJLF)
- Leachate Discharge Monitoring (SJLF)

Also included in this plan is a Sampling and Analysis Plan, which describes the methods and procedures that will be used to collect and analyze samples for each component, as well as procedures which are common to all components.

Within each component, two or more monitoring strategies are described. These strategies address different but interrelated objectives, all of which are oriented toward meeting regulatory requirements. The strategies are described further in the plan under each component. Some of the strategies involve regularly scheduled monitoring, while others involve short term monitoring, depending on the specified objectives.

Included under each component are discussions of key factors which influence monitoring (see "Factors Integral to Monitoring Design"). These discussions provide context for the monitoring plan in three ways:

- Rationale for monitoring strategies
- Current understanding of unanswered questions
- Direction for future modification of the plan

Where appropriate, monitoring will include assessing risks to public health or the environment, using collected data. Risk assessment may include analysis of biological tissues, such as fish. A tissue monitoring component has not been included in the plan, as objectives have not yet been defined. It is expected that the evaluation of data collected through the plan will provide direction for tissue monitoring requirements and strategies.

Prospective Changes in Hydrology Within SBWA

A key assumption reflected throughout the monitoring plan is the return of Smith and Bybee Lakes to intertidal wetland through removal of an existing earthen dam in the North Slough arm of the Columbia Slough (scheduled for late Summer or early Fall, 1998). The dam will be replaced with an open water control structure designed to allow natural tidal inflow and outflow but retain water in the lakes as necessary to achieve SBWA management objectives.

Removal of the dam will have a significant effect on water flows and elevations within SBWA, which is expected to affect the nature of environmental contamination. The critical pathway for tidal water into the lakes will be the North Slough arm along the north flank of SJLF. The plan includes strategies for investigative monitoring related to dam removal, and to subsequent hydrology management actions. Results of this monitoring will serve to provide early detection of significant changes in environmental quality, and to facilitate management decisions.

Environmental Quality Data Management

Data collected through this plan will be managed within Metro's Environmental Monitoring Information System (EMIS), a relational database which has been customized for organizing environmental quality data, and for providing a platform for data evaluation. Uses of the data managed within EMIS will include, but are not limited to, statistics-based assessments of significant changes in environmental quality, regulatory compliance checks, inputs to modeling the rate and direction of groundwater movement, and risk assessments. These uses depend on the media being monitored, and are described further within plan components.

Section 1

Groundwater Quality Monitoring

Introduction

The Groundwater Quality Monitoring Plan for St. Johns Landfill (SJLF) includes monitoring of groundwater at SJLF and off-site near the landfill. Some of the off-site groundwater wells that are regularly monitored under this plan are located outside of the Smith-Bybee Lakes Wildlife Area (SBWA). Monitoring these and other off-site wells is required to provide sufficient data for assessing the effects of SJLF on the surrounding environment.

Metro has finished constructing the cover system for St. Johns Landfill (SJLF), including the gas collection and stormwater systems. The multi-layered cover includes compacted soil, low density polyethylene membrane, geogrid, and/or sand drainage layer, top soil, and vegetation. It is expected that the cover will essentially eliminate infiltration of rainfall into solid waste, which causes the formation of a mound of contaminated wastewater (leachate) within the landfill. This mound of leachate is the driving force for the movement of contaminants through the groundwater.

The plan comprises the following:

- Objectives
- Regulations
- Factors Integral to Monitoring Design
- Monitoring Strategies
- Sampling and Analysis Plan (see Section 6)
- Table A: Groundwater Quality Monitoring Parameters
- Table B: Groundwater Monitoring Wells and Piezometers Currently Useable
- Table C: Groundwater Monitoring Well and Piezometer Summary
- Figure 1: Groundwater Monitoring Well Screen Elevations
- Figure 2: Map of Active Groundwater Monitoring Well and Piezometer Locations (see Appendix for Tables and Figures)

Objectives

Groundwater is the vehicle for current and potential movement of various environmental contaminants from wastes within SJLF into the surrounding environment. For this reason, the primary objective of groundwater monitoring at the landfill is to collect water quality and water level data for assessing the landfill's current and potential contribution to contamination of surrounding surface waters, sediments, and groundwater, and to assess any associated risks to the environment and public health.

The collected data, together with a verified groundwater model of the landfill, will be used to make estimates of current and future groundwater and contaminant movement. Ultimately these estimates will serve to make assessments of environmental impacts and, where required, to facilitate cost-effective environmental management decisions. The primary tool for making these estimates is a groundwater model being developed by Metro. The objective of modeling efforts is a comprehensive understanding of the landfill site and its interactions with the surrounding surface and groundwater systems.

Achieving plan objectives will allow for determining compliance with specific regulatory goals, namely surface water TMDLs for the Columbia Slough (*i.e.*, possible load allocations for SJLF) and acceptable levels of risk under the Oregon Environmental Cleanup Law.

Key elements of the plan for achieving the primary objective include:

- Collect water quality data which are representative of the aquifers being monitored
- Identify significant changes/trends for a given contaminant and well using statistics-based evaluation;
- Determine whether groundwater quality data and water level data support the predictions of the groundwater model;

These elements are incorporated into the three monitoring strategies which will be implemented to provide a basis for evaluating monitoring data to meet plan objectives.

<u>Strategy 1: Evaluate Data for Short-Term Impacts and Long-Term Trends</u>: Groundwater data will be regularly collected and evaluated for the presence of contaminants from solid waste leachate and any other sources, in order to evaluate short-term impacts and long-term trends on the environment surrounding SJLF.

<u>Strategy 2: Evaluate Water Level Data to Assess Flow Patterns</u>: Groundwater level data will be regularly collected to characterize general flow patterns of groundwater in the vicinity of SJLF, and to provide essential input to the SJLF groundwater model.

<u>Strategy 3: Address Specific Questions through Short-Term Investigations</u>: Specific questions will be addressed through short-term investigative monitoring.

Locations and parameters monitored under any of these strategies may change based on modification of plan objectives, or new goals developed for the monitoring program.

Regulations

The regulations listed below are applicable to Metro's monitoring and management of groundwater underlying SJLF and within the SBWA, and are reflected in the plan's objectives and strategies.

- Chapter 340, Division 40: Groundwater Quality Protection Rules
- Chapter 340, Division 41: Surface Water Rules (i.e. Water Pollution Rules)
- Chapter 340, Division 94: Solid Waste: Municipal Solid Waste Landfills
- Chapter 340, Division 122: Hazardous Substances Remedial Action Rules
- Oregon Environmental Cleanup Law
- Federal Clean Water Act, (Section 303(d)) TMDL
- Solid Waste Disposal Site Closure Permit (#116)
- Industrial Wastewater Discharge Permit (#400.018)

Oregon Environmental Cleanup Law Listings

The regulatory framework for environmental monitoring at SJLF changed in 1995 when DEQ added SJLF to two lists of sites which are subjected to the Oregon Environmental Cleanup Law through the Hazardous Substance Remedial Action Rules. One list includes sites in Oregon with confirmed releases of hazardous substances (Confirmed Release list); the other includes an inventory of sites in various phases of investigation and remediation (Inventory). Twenty-four chemicals were listed as substances of potential concern. These have been detected in leachate contained in the confines of the solid waste or in nearby groundwater.

The listing of SJLF requires that remedial investigation and action be formally addressed. This could range from an official recognition that current actions and plans constitute remediation under Hazardous Substances Remedial Action Rules, to additional actions including further monitoring and investigation, and institutional or engineering controls.

The nature and level of effort required is determined in part by how a site is categorized on the Inventory. DEQ categorizes sites based on their status in the remedial process, as follows, and in 1997, categorized SJLF as a Phase II site:

- Phase I: RI/FS has not been initiated
- Phase II: RI/FS are underway
- Phase III: RI/FS completed, and remedial design, remedial action, or removal are underway

- Phase IV: all necessary remedial actions or removal are complete, except for continuing operation/maintenance or other controls necessary to protect health and the environment

In 1995, with the passage of HB 3352 (described below), the Oregon Environmental Cleanup Law (Cleanup Law) was substantially amended to require that any remedial action of a listed site be based on beneficial use determinations for the purpose of ascertaining acceptable risk levels. Environmental protection is to be achieved through risk reduction and risk management. To implement the law, the Hazardous Substances Remedial Action Rules were amended by DEQ, and were be adopted by the Oregon Environmental Quality Commission (EQC) in January, 1997. The amended rules will include a risk protocol developed by the EQC, including specifications for developing assumptions, sampling and analyzing environmental data.

In early 1996, DEQ informed Metro that staff of the Solid Waste Section would be the liaison between Metro and other DEQ programs such as the Environmental Cleanup Division, the division which enforces the Cleanup Law. Under this arrangement, the future regulatory framework for SJLF will be the Environmental Cleanup Division rules (i.e. the amended Hazardous Substances Remedial Action Rules) enforced through the Solid Waste Disposal Site Closure Permit.

1995 Amendments to The Oregon Environmental Cleanup Law

On July 18, 1995, HB 3352 was signed into law, giving DEQ the mandate to adopt or amend rules that govern the cleanup of sites on the Inventory or Confirmed Release lists (Hazardous Substances Remedial Action Rules). The rules were amended by DEQ and were adopted in January, 1997, by the Oregon Environmental Quality Commission (EQC). The amended rules include a risk protocol developed by the EQC, including specifications for developing exposure and toxicity assumptions, interpreting results, and selecting and applying contaminant fate and transport models. Under these rules, environmental protection is to be achieved through risk reduction or risk management. Cleanup is no longer focused on achieving contaminant concentration standards, such as background levels or lowest feasible concentration. Rather, it focuses on being protective of current and reasonably likely beneficial uses -- such as recreational, industrial, agricultural, and drinking water -- based on risk assessment. The method of remedial action selected or approved by the director will be based on a balancing of factors including effectiveness, reliability, cost and ease of implementation.

Of significance for groundwater monitoring at SJLF is that DEQ will no longer presume that drinking water is a beneficial use for all groundwater and surface water. SJLF was listed in part because levels of some groundwater contaminants exceeded EPA drinking water standards (i.e. the Maximum Contaminant Level or MCL). Groundwater underlying and surrounding the landfill is not currently used for drinking water, nor is it reasonably likely that it will be used as such in the future, based on current plans and development in the area. Therefore, based on the amended rules, it will not be included as a pathway in the SBWA site conceptual model for risk assessment (see below under Risk Assessment Perspective for St. Johns Landfill). However, MCLs for drinking water will continue to be used in evaluating groundwater data for significant changes and trends (i.e. to identify contaminants and locations which may pose risk to the surrounding environment).

The amendments create a new category of contamination -- hot spots. Hot spots are areas where there are, or could be beneficial uses, and where concentrations of hazardous substances have significant adverse effect on those uses, based on risk assessment. Adverse effect occurs where contaminant concentrations pose an unacceptable level of risk. The level of acceptable risk for human exposures is one per one million lifetime excess cancer risk for carcinogens, and a hazard index equal to one for non-carcinogens. A hazard index is the sum of the noncarcinogenic risks (hazard quotients) attributable to systemic toxicants with similar toxic endpoints. A hazard quotient is the absorbed (or actual) dose divided by the reference dose for an individual contaminant with the reference dose being the level beyond which exposure to the toxicant for an extended time may have significant adverse effects.

For ecological receptors, the acceptable level of risk is the point before significant adverse impact occurs, based on the probability of an exposure exceeding a benchmark. This includes impacts to the health and viability of an individual of a species listed as threatened or endangered (plants or animals), or to a population of a non-threatened or non-endangered species in the locality of the site.

Risk thresholds are summarized below:

Human Health:	individual carcinogens	($> 1 \times 10^{-6}$ lifetime excess cancer risk)
	multiple carcinogens	($> 1 \times 10^{-5}$ lifetime excess cancer risk)
	noncarcinogens	(hazard index > 1)
Ecological:	level which would cause significant adverse ecological impact	

An exception to the above thresholds is where drinking water is a beneficial use, and an applicable or relevant groundwater quality standard is available (e.g. an MCL); in such cases, the hot spot threshold is the MCL or other applicable standard. In the absence of an acceptable water quality standard, the hot spot threshold is the acceptable risk level defined above.

Confirmed hot spots technically require treatment, but only if treatment can restore or protect beneficial uses within a reasonable time. Treatment does not necessarily involve cleanup, in the sense of excavation or disposal. It could involve on-site treatment of hazardous substances (such as a cover), or limiting or preventing exposure (e.g. institutional controls) to achieve acceptable risk levels.

Under the amendments, probabilistic methods for assessing risk may be applied to any or all of the primary inputs to the extent practicable, including for example, environmental media contaminant concentration data, transport and fate modeling, exposure estimation, and toxicity estimation. The result of this approach is a range of probabilities of risks actually occurring.

Surface Water Regulations

Regulations pertaining to surface water are also relevant to the groundwater monitoring plan. While the Cleanup Law focuses on soil and groundwater of contaminated sites and adjacent properties, SJLF is surrounded by surface waters, and groundwater is the pathway for contaminant movement from wastes into the surrounding environment including surface water. Among surface water rules, likely to take precedence are Total Maximum Daily Load (TMDL) requirements of the Clean Water Act, implemented by DEQ's Water Quality Division.

Based on the Clean Water Act (Section 303(d)), every two years DEQ releases a list of water bodies and waterways which are "water quality limited", meaning that the quality of these waters do not support beneficial uses as they either violate water quality standards for pollutants listed in Section 307(a) of the Clean Water Act, or have had a human health advisory issued by the Oregon Health Division. The list serves as the basis for DEQ to set priorities for developing Total Maximum Daily Loads (TMDLs) or management strategies to bring waters back into compliance with water quality standards, associated waste load allocations for point sources of pollution, and load allocations for non-point sources.

The Columbia Slough and both Smith and Bybee lakes are included among waters designated as water quality limited and targeted for TMDLs. SJLF is one the sources of contamination identified by the Columbia Slough Water Body Assessment (WBA) for the Columbia Slough, and is subject to TMDL requirements. The draft Columbia Slough TMDL (June 26, 1997) allocates an annual load for total lead to SJLF, of 2.88 lb.

TMDLs for toxic contaminants will be based in part on Table 20 of Surface Water Rules, which provide guidance concentrations of chemical compounds which are not to be exceeded in waters of the state for the protection of aquatic life and human health.

The groundwater monitoring plan is consistent with the Smith-Bybee Lakes Natural Resources Management Plan in that it implements a monitoring program which assures "early detection of potential environmental problems," and is "designed to protect the environment from unwanted landfill impacts," as required by that plan.

Factors Integral to Monitoring Design

Following are lists and summaries of factors that are reflected to varying extent throughout the plan. They are integral, or potentially integral to the design of monitoring implementation strategies (measurements and locations), and will be incorporated as required into data evaluation.

__Potential Sources of Groundwater Contamination within Smith-Bybee Lakes Wildlife Area__

Potential sources which may be contributing to contamination of groundwater within SBWA include:

- DEQ-listed cleanup sites
- Possible unpermitted discharges to groundwater and unknown contaminated sites
- St. Johns Landfill
- Flooding

Leaching of contaminants from waste materials which are stored, disposed or discharged is the primary source of groundwater contamination. Contamination of the silt aquifer underlying SJLF (i.e. floodplain sediments) is generally assumed to be the result of leaching from solid waste in the landfill. However, the source of contaminants which have been detected in the deeper regional Pleistocene gravel aquifer underlying the landfill (e.g. volatile organic compounds) is not necessarily solid waste leachate. These contaminants may have migrated from other areas of the aquifer.

Currently, the landfill's contribution to contaminants (e.g. volatile organic compounds) which have been detected in wells screened in the gravel aquifer across the Columbia Slough from the landfill is not clear. However, the landfill's contribution, if any, may be better understood after further well data evaluation and groundwater modeling.

Another source of groundwater contamination is flooding such as occurred during the winter of 1995-1996. Heavy rains in December 1995 caused the water level of the Columbia Slough to rise to a point where it covered the lowest portions of the perimeter road around the landfill. Heavy rain and snow melt in February 1996 led to serious flooding of the entire Smith and Bybee Lakes area with water levels overtopping the higher points of the perimeter road around the landfill. This resulted in infiltration of surface water, and possible introduction of contaminants from surface water sediments through the perimeter dike around the landfill. Flood waters covered some monitoring wells and piezometers around the landfill, causing damage or destruction to groundwater elevation data loggers, and likely entered some of the monitoring casings.

__Risk Assessment Perspectives: St. Johns Landfill__

The 1994 *Screening Level Risk Assessment for the Smith-Bybee Lakes Management Area* included a Site Conceptual Model for risk assessment. This model identifies contaminant sources, mechanisms of release into the environment, pathways to exposure, and receptors (human, wildlife, and aquatic organisms), and is used as a basis for risk assessment. In its letter of September 23, 1996 to Metro, DEQ requested an update the Site Conceptual Model to reflect new understandings stemming from further development of the groundwater model. Metro will also update the model to reflect the amended Cleanup Law rules, where necessary.

Three perspectives provide an overview of risks which are assumed to be the result of environmental contamination from solid waste in SJLF. These are summarized below in the context of groundwater and surface water/sediment beneficial use determinations, as required by the Cleanup Law amendments.

1. On-site risks at SJLF

   - There are currently no beneficial uses of groundwater underlying SJLF, and it is not reasonably likely that there will be beneficial use in the future, based on current plans. It will not be included as a pathway in the site conceptual model for risk assessment.

2. Off-site risks (surface water, sediment)

   - Currently, there is recreational use of surface waters around the landfill, including boating, fishing, wading and swimming. These waters and sediments are part of the SBWA ecosystem, and are also beneficial to many animals, particularly aquatic organisms which reside in the water column and sediments, and fish-eating wildlife. The extent to which the area is used in these ways will likely increase in the future.
   - Previous and ongoing studies of the Columbia Slough indicate that some contaminants currently found in the Slough may have significant adverse effects on beneficial uses in certain areas.
   - Contaminants from SJLF discharge to surface waters around the landfill through perimeter dike seep, and potentially through contaminant migration offsite in the gravel aquifer and upwelling into surface waters (e.g. the assumed gravel ridge "window" with Bybee Lake).
   - Assessing risks requires the following inputs: educated estimates of groundwater contaminant discharge into surface waters surrounding SJLF (approximate location and rate of discharge, both for the highly mobile constituents of existing seepage, and future predicted discharge for selected contaminants based on estimated retardation factors); estimated ambient concentrations in a surface water mixing zone, if any, based on applied dilution and dispersion factors; estimated contaminant deposition to sediment within this mixing zone. A fugacity model may be required to estimate partitioning into surface water, sediment, and air, of contaminants discharged from groundwater.

3. Off-site risks (gravel aquifer)

- A groundwater beneficial use survey of SBWA and vicinity is required to identify areas where groundwater is currently used for industrial or irrigation purposes, or is reasonably likely be used in the future. Current information regarding groundwater use in the area is assumed to be dated due to the recent rapid development of the Rivergate Industrial Park, and will be updated.
- For areas where the beneficial use survey indicates groundwater may have, or is reasonably likely to have beneficial uses, the groundwater model should be used to make educated estimates of the rate of contaminant introduction into a specified area of the regional sand/gravel aquifer where it is determined that groundwater is withdrawn for beneficial use (e.g. commercial or irrigation).

Seepage Control Plan: St. Johns Landfill

Seepage is liquid and dissolved contaminants which originate in the waste in SJLF and migrate to the immediately surrounding surface water, including Smith Lake and the Columbia Slough and its North Slough arm. The mechanism for this has been rain water percolating through the waste and leaching out contaminants. Some contaminants from this "leachate" in the solid waste move downward into the groundwater through the floodplain sediments underlying the waste, and seep sideways through the perimeter dike to surface water. Some of the seepage is localized as visible seeps, while some is diffuse, non-visible seepage.

The perimeter dike includes both a natural dike around the older part of the landfill, and an engineered dike which was constructed in 1980-81 as part of the expansion of the landfill. Most of the seepage appears to be through the natural dike, while the engineered dike shows no visible seepage. Both dikes have low permeable soil and topography which retard the rate of seepage, possibly even preventing the more toxic and less mobile contaminants in the waste from migrating through. In addition, the rate of seepage will decrease in time because rainwater percolation through the waste has been essentially blocked by the geomembrane cover.

In May 1995, Metro submitted to DEQ a Seepage Control Plan for the St. Johns Landfill. Its purpose was to gain DEQ approval of this element of Metro's plan to close the St. Johns Landfill. That plan first defined the problem by presenting a body of information collected by Metro about the past history of St. Johns Landfill and about the characteristics of the soils and groundwater surrounding the solid waste. Estimates were presented of the flow rate (flux) to surface water from both the visible surface seeps in the natural dike and also from diffuse, non-visible seepage through the dike. These estimates were based on monitoring well data and preliminary estimates from the groundwater flow model.

The Seepage Control Plan identified the geomembrane cover system as the most important method for managing both diffuse seepage and visible surface seeps because it blocked the driver of seepage (i.e. rainwater adding to the leachate mound). The plan presented several possible mechanisms for managing visible surface seeps, including monitoring, patches and cut-off walls of compacted low permeability soil, tree planting, perimeter drains and leachate pumping.

Direct monitoring of visible seeps is not included in this plan. Rather, five groundwater monitoring wells (K-series) are monitored for movement of contaminants through the dike. These wells are screened at shallow depths in the dike between the waste and adjacent surface waters. They are a more conservative measure than actual seepage of contaminants discharging to surface water because they are closer to the waste, and they do not reflect changes in leachate constituents which may occur in seepage at the soil-air or soil-water interface, possibly as a result of microbial action or dissipation.

In addition to monitoring of the K-series wells for water quality parameters, water level data from piezometer clusters located in the dike are used to determine variations in groundwater flow directions and gradient between the landfill and the surface water in the sloughs.

Dioxin Investigation: St. Johns Landfill

The dioxins and related organic compounds in the environment are commonly of concern because of their high toxicity. The dioxins have not been directly measured in SJLF groundwater, but solid waste and leachate have been analyzed for its surrogates, and soil studies. Groundwater modeling and soil sorption studies have indicated that the probability of movement of dioxins through soil in the landfill to the surrounding surface waters or the gravel aquifer is extremely low.

In 1985, EPA conducted a National Dioxin Study which focused on dioxin produced as an unwanted byproduct of pesticide manufacture. Study sites throughout the U.S. included 20 places where pesticides were produced or used, and 76 sites where pesticide manufacturers/users sent their wastes, including SJLF. It is believed that between 1958 and 1962, residues from the manufacture of 2,4-D by the Rhone-Poulenc Chemical plant in Portland were disposed in SJLF. To determine whether dioxin (which may have been in the residues) was in the landfill, solid waste and solid waste leachate samples were collected where geophysical tests indicated that drums of 2,4-D may have been buried. Samples were not analyzed for dioxin, but rather for various pesticides associated with dioxin. If the pesticides were found in significant levels, sampling for dioxin analysis would follow.

The study concluded that, based on the data, follow-up analysis for dioxin was unnecessary, and that dioxin and furan congeners, if present in the landfill, would not likely pose a significant public health or ecosystem threat due to the lack of an exposure mechanism (i.e. these compounds would be strongly adsorbed to solid waste and surrounding soil in the landfill such that migration potential would be low).

The study also included the analysis of other contaminants in solid waste and solid waste leachate, including metals, PAHs and VOCs. Some of these were measured at levels which the study concluded were of potential concern.

More recently, Dr. William Fish of The Oregon Graduate Institute of Science and Technology has measured sorption in 40 samples of the low permeability soil around the solid waste in St. Johns Landfill. He concluded that hydrophobic compounds such as the dioxins and dibenzofurans are "virtually immobile in this environment and should be considered a low priority in planning future transport investigations."

Since the EPA study, Metro has implemented comprehensive environmental monitoring of SJLF, involving the analysis of a multitude of chemicals in various media (including priority pollutant scans of groundwater). The purpose of this monitoring is to ensure early detection of contaminants which migrate from the solid waste to the environment. The groundwater monitoring plan is specifically designed to detect a wide range of contaminants which migrate much more rapidly through soil around the solid waste than the dioxins and dibenzofurans. Detection of these would give an early warning that the dioxins and dibenzofurans should analyzed. This is believed to be a more effective approach than trying to test many samples for dioxins and dibenzofurans at extremely low levels where analytical difficulties due to matrix interferences, equipment contamination, etc. would likely cloud the results.

<u>Leachate Monitoring: St. Johns Landfill</u>

The composition of leachate sampled directly from the waste in SJLF provides important baseline data from the primary source of contaminants within the landfill. This information is referenced as needed in evaluating groundwater quality data for the landfill and vicinity. It includes data from 4 wells constructed in 1985 as part of the EPA National Dioxin Study (see previous section). This data includes leachate indicators, dissolved metals, volatile organic compounds, pesticides and PCBs.

All 4 wells from which these data were collected have been abandoned, in part due to the construction in 1990 of 5 new wells in the interior of SJLF, in each of the five sub-areas of the landfill which were delineated for closure purposes. All of these H-series wells are screened in the solid waste. In 1991, leachate was sampled from these wells and analyzed for conventional parameters, leachate indicators, dissolved metals, volatile and semi-volatile organic compounds. Additional data will be collected from these wells as required to meet the objectives of this plan.

Well water elevation is measured monthly in H-wells, and periodic surveying of the wells is performed to account for any elevation changes due to settlement beneath the wells.

Leachate characteristics have also been obtained through sampling from two locations in a leachate collection system on the landfill which pumps a mixture of leachate and landfill gas condensate to the City of Portland sanitary sewer system. The two locations include a wet well in the landfill expansion area (Sub-Area 5) from which the leachate/condensate is pumped to the sewer, and an in-line valve near the north end of Landfill Bridge.

The in-line valve is the sampling point for fulfilling the monitoring requirements of the BES wastewater discharge permit held by Metro for discharging leachate from the landfill to the City sewer (see Leachate Discharge Monitoring Plan). Based on the permit, leachate is sampled monthly for measurement of ammonia and pH, and twice per year for a host of contaminants, including total heavy metals, total petroleum hydrocarbons, total phenol, total oil and grease, volatile and semi-volatile organic compounds, and pesticides and PCBs. In addition to its use in determining compliance with the wastewater discharge permit, this data will be used as needed in the evaluation of groundwater data from the landfill and vicinity.

Statistics-Based Data Evaluation

Statistical analysis is recognized by regulatory agencies as the most objective means of detecting and confirming significant changes and trends in groundwater quality. For evaluating groundwater underlying and surrounding municipal solid waste landfills, DEQ has generally deferred to methods outlined in RCRA (40 CFR 258) (i.e. Subtitle D).

Specific methods are approved under Subtitle D, and are designed to detect initial contamination of wells, differentiate between a release from a site and a release from sources upgradient of the site, determine the extent of release, and assess the effectiveness of remedial actions. Conservative statistical error criteria are specified in order to minimize the risk of false negative measurements (concluding that groundwater is clean when it is not). However, this leads to the risk of false positive measurements (concluding the groundwater is contaminated when it is not). The risk of false positive measurements also increases with site size and the number of monitoring wells and analytes. SJLF is a relatively large site with large number of wells and analytes, and a correspondingly high risk of false positive measurements. Due to the size of site complexities at SJLF and vicinity, selected statistical methods should be oriented toward minimizing false measurements generally. This is important in that even one exceedence of a contaminant of interest in a critical location has implications for remedial action.

Choice of the most appropriate statistical methods is one of the more complex problems in groundwater monitoring, as each method requires that certain conditions be met. There is no single statistical test that is appropriate for every site. In fact, the most appropriate test for a specific site or even for certain wells or constituents at a site may change over time. Factors which must be considered in making the appropriate choices and interpretations include:

- distribution of the data
- number of observations
- natural spatial variation (e.g. due to hydrogeology)

- availability of background data
- characterization of aquifer gradients
- off-site sources of contamination

Site characteristics should also be considered in the application of statistics. At SJLF, relevant characteristics may include, but are not limited to the following:

- heterogeneity of waste in various areas of the landfill
- hydrologically separated areas of the landfill
- contamination in the vicinity of the landfill by other sources
- most active monitoring wells installed after waste was deposited

At RCRA and CERCLA sites statistics are typically used to compare wells which are hydrologically downgradient from the waste management area to wells which are upgradient from that area. The working assumption behind this approach is that the upgradient wells are uncontaminated by releases from the site or other sources, and therefore represent background. Then, data from downgradient monitoring wells (commonly referred to as "compliance" wells) are compared to this background for evidence of contamination. This approach is referred to as interwell analysis.

Interwell analysis is designed to demonstrate statistically significant differences from one well to another resulting from contaminant releases originating in the waste or caused by leachate from the waste. This analysis requires that hydrogeologic conditions are uniform throughout the site, that uncontaminated, upgradient wells provide background data, and that monitoring wells being compared are screened in the same interval (layer). If these conditions are not met, improper conclusions about contaminant migration and potential impacts may be drawn.

For leachate indicators and heavy metals which occur naturally in groundwater, interwell analysis cannot distinguish between a statistical difference in these parameters caused by release of site contaminants and a statistical difference caused by natural hydrogeologic variation, potentially leading to false positive measurements.

Intrawell analysis is often applied where site conditions make interwell comparisons difficult or inappropriate. This approach involves comparisons of recent data for a "compliance" well with historical data for that well, which is presumed to represent background. It is intended to discern significant changes and trends in a given well over time.

Intrawell analysis does not require homogeneous hydrogeology underlying the site, but does require that historical data have not been previously impacted by site releases -- so that this data can serve as background. This can be difficult to demonstrate where waste was deposited prior to groundwater monitoring, as is the case at SJLF.

Even though solid waste may have been present nearby before a well was constructed, a three-step method may be used to justify the use of intrawell analysis (i.e., comparison to background for detecting contaminants in a well considered to be previously not contaminated):

1. screen for the presence of volatile organic compounds (VOCs)
2. determine whether inorganics are detected above natural background
3. remove statistical outliers from prospective background data

For a given well, if VOCs are not present, and inorganics (e.g., conservative tracers such as chloride) are not detected or are below "background" in historical data, the historical data may be used for evaluating new data, after the removal of any statistical outliers.

However, where historical data indicate existing contamination, new data may be compared against prediction limits based on the historical data, as a means of detecting significant change from, and trend in the existing level of contamination.

Monitoring Strategies

Overview

The three monitoring strategies described in this section represent a comprehensive approach to characterizing short and long-term movement of groundwater and contaminants in the two principle hydrogeological units under SJLF and vicinity -- the floodplain sediments and the Pleistocene gravels. This characterization will provide essential information for assessing the impacts of the landfill on the surrounding environment.

- Strategy 1: Evaluate Groundwater Quality Data for Long-Term Trends
- Strategy 2: Evaluate Groundwater Level Data for Flow Patterns
- Strategy 3: Conduct Short-Term Investigations as Required

The strategies are expected to evolve based on refinement and focusing resulting from the interplay of the following:

- hydrogeologic site characterization
- characterization of groundwater flow patterns
- predictions of groundwater and contaminant movement
- statistical assessments of the data to determine the presence and magnitude of contaminants
- review by DEQ of reports prepared by Metro
- regulatory changes

Strategy 3 (short-term investigations) is intended to address questions which may arise based on results, or otherwise to provide further information at selected locations through short-term investigative monitoring. Monitoring methods may be modified based on the findings of such investigations.

Modifications within the three strategies may include, but are not limited to:

- the addition or removal of monitoring stations
- revision of modeling assumptions and inputs
- changes in groundwater quality monitoring well sampling frequency and testing parameters
- changes in sampling and analytical methods

Strategy 1: Evaluate Data for Short-Term Impacts and Long-Term Trends

Objective. This Strategy monitors the two primary hydrogeological units underlying SJLF and vicinity for the presence of solid waste leachate constituents, and contaminants from any other sources, in order to provide essential information for the assessment of current and future environmental impacts of the landfill on the surrounding environment.

Achieving this objective requires regular monitoring of the overbank silts around the landfill perimeter for contaminant movement toward adjacent surface waters, and of Columbia River sands and Pleistocene gravels around the landfill for contaminant movement toward the deeper, regional hydrogeological unit.

The number and location of monitoring wells must be sufficient to provide representative data of the 220 acres site and immediate vicinity. To ensure effective characterization of, and early detection of significant changes in groundwater quality, sampled groundwater will be analyzed for the range of chemical classes which may be represented in solid waste leachate.

The methods outlined below are oriented toward providing essential feedback for modification of monitoring -- namely, monitoring locations and analytes -- in order to increasingly focus efforts for the purpose of generating the most useful data for cost-effective management.

Measurements/Wells. Groundwater from 30 monitoring wells (Table B) will be sampled and analyzed twice per year, including 19 wells screened in the floodplain sediments, and 11 screened in the Pleistocene gravels. Analytes will include leachate indicators (e.g. ammonia, dissolved chloride, conductivity), heavy metals, and VOCs. EPA priority pollutants (e.g. SVOCs, pesticides, PCBs) will be analyzed once per year at a subset of the 31 wells. The number and location of wells selected for priority pollutant analysis will vary depending on evaluation of previous data (see Data Evaluation strategy below), groundwater modeling, and short-term investigations.

Table A lists all parameters which will be measured, either in the field or laboratory. The table includes parameters required to assess regulatory compliance with prospective TMDL load allocations (e.g., total recoverable lead).

Data Evaluation. Following is a strategy for systematic and routine evaluation of groundwater quality data which involves characterizing existing data for each monitoring well, and evaluating new data for significant changes. The strategy will serve three primary purposes:

1. Enhanced data integrity through early identification of significant changes, testing for statistical outliers, and verification resampling if necessary.
2. Detect significant changes in groundwater quality early to allow for timely assessment of any associated risks if necessary, and to implement appropriate actions where required.
3. Organize and evaluate data to facilitate its use in the groundwater model, and to test model predictions of the rate and direction of contaminant movement.

Data Characterization
Data will be characterized using graphic representation or statistical analysis which allows for comparison of wells in regard to extent of contamination, and which provides a basis for identifying significant changes in data over time (e.g., trend charts). It will also serve to identify suspect observations in existing data sets, and where necessary testing to determine if these observations are statistical outliers.

Data characterization will include a general classification of wells based on the concentration or apparent absence or presence of contaminants by chemical class, including:

- leachate indicators (e.g. chloride, ammonia, dissolved calcium)
- heavy metals
- volatile organic compounds (VOCs)
- semi-volatile organic compounds (SVOCs)
- pesticides
- herbicides
- polychlorinated biphenyls (PCBs)

Among other differences, the constituents of these chemical classes generally differ in their mobility in groundwater (i.e. retardation factor due to sorption), persistence and toxicity. For example, leachate indicators are generally more mobile, less persistent and less toxic than heavy metals; heavy metals are generally more mobile, less persistent and less toxic than pesticides. Also, some metals and leachate indicators are naturally present in groundwater in low concentrations (i.e., background).

The key assumption behind classifying wells is that the presence of leachate indicators above background in a given well indicates a pathway through groundwater for some contaminants in leachate from the waste to that well. Less mobile constituents of leachate may follow, beginning with the more mobile heavy metals and VOCs, followed by constituents of other classes (SVOCs, pesticides, herbicides, PCBs) which are less mobile. For example, in wells where leachate indicators are already present, data generally indicate elevated levels of some of the heavy metals. Some of the leachate indicators such as chloride may cause desorbtion of metals naturally occurring in the aquifer. Alternatively, metals may have migrated from the solid waste.

Significant Change Determination
Significant change is defined here as the occurrence of a data point outside of an expected range, or exceedence by a data point of an expected maximum value. Ranges or comparison values will be established through the characterization of existing data.

To determine whether such data is erroneous or represents actual significant change in groundwater quality, one or both of the following methods will be used, depending on circumstances:

- verification resampling and analysis
- testing for statistical outliers

Where a data point is higher than existing data by orders of magnitude, it will be tested as an outlier using the T_n test (one-sided test), assuming the data are log-normally distributed. This procedure follows EPA guidance for statistical analysis (1989).

Anomalous data points may be tested as outliers even where a significant change is verified through resampling. Alternatively, an outlier test may be used to make a decision regarding whether or not to resample. For example, because of the magnitude of deviation from existing data, a statistical outlier is assumed to be the result of error, and may not require resampling. Where there is low confidence in this conclusion, verification resampling may be employed.

Alternative measures of significant change which will be reviewed for potential use include the following:

- pre-determined number of standard deviations from the mean of the existing data set.
- box plots (with an upper limit value equal to the 75th percentile value plus three interquartile ranges)
- Shewart-CUSUM control limits
- prediction intervals

Data Evaluation Procedure
Following is a procedure for meeting the data evaluation goals described above:

1. Data Characterization:

   - classify wells based on the extent of contamination for general interwell comparisons

- establish limits for intrawell comparisons to identify significant changes in new data
- identify suspect data in existing data sets, and test as statistical outliers where necessary

2. Compare new data to existing data using limits establish in Step #1
3. Where new data exceed limits (including first-time detections), resample to verify statistical outliers
4. Label confirmed outliers in EMIS database
5. Identify significant change in groundwater quality
6. Determine whether the change is consistent with predictions of the groundwater model
7. Modify groundwater model inputs or assumptions if appropriate
8. Modify analytes to be measured and install new monitoring wells if appropriate
9. Conduct short-term, investigative monitoring if warranted
10. Assess risks associated with change in groundwater quality, if necessary

Strategy 2: Evaluate Water Level Data to Assess Flow Patterns

Objective. Water level data will be collected and evaluated to characterize general flow patterns of groundwater in the vicinity of SJLF, and provide data to calibrate and validate the SJLF groundwater model. Groundwater flow rate and direction is influenced by complex changes in level (height) of the overlying silt aquifer and pressure in the underlying sand/gravel aquifer caused by factors such as rainfall and the rise and fall of the Willamette and Columbia Rivers.

Surface water elevation data in waters surrounding SJLF will also be analyzed and compared with groundwater elevations to assess interactions between surface water and groundwater.

Measurements/Wells. Both piezometers and monitoring wells will be monitored regularly as described below. Collected data will be evaluated by plotting daily average elevations for electronically logged continuous data, as well as manually collected point data. These plots will be used to study the vertical and horizontal gradients.

Continuous water level data will be collected electronically in six monitoring wells penetrating the top of the sand/gravel aquifer, including D-6C, G-4B, G-5B, G-6, G-8B and G-8C. Water levels will also be recorded manually, both as a check on the logged data, as well as a way to calibrate the piezometers (by determining when the aquifer essentially has a flat water surface).

The sand/gravel aquifer is continuously monitored because the water pressure is not as much a function of depth as in the silts and clays of the shallow aquifer. Also, the placement of the sensors, always towards the top of the gravel unit, is consistent. Therefore, it is possible to readily compare to data at other locations.

Measurements/Piezometers. Piezometer data at multiple depths in the silts, sands, and gravels will be collected either continuously or monthly. The data loggers were installed at the locations of greatest current interest (see below), with the anticipation of moving the loggers as required over time. Monthly data will be taken at all other piezometer locations.

The multi-level vibrating strip pressure transducers were installed as a string, and then backfilled with bentonite between each sensor. They are at 9 different locations around the perimeter of the landfill, including one at the edge of Smith Lake and a second at the edge of Bybee Lake. Six of these have shallow monitoring wells drilled a few feet away, which allows comparison and approximate verification of the water level data. Five (of the six) locations being continually monitored are at the lakes or adjacent to them, so the interaction between the surface and groundwater can be studied. Continuous monitoring data is also collected at P1, because it is a relatively deep boring (on the southwest side of the landfill), which responds differently than the other piezometers in the sand/gravel aquifer (except P6).

The number of transducers per piezometer cluster varies from three to five. The most shallow sensor location was selected relative to the level of the adjacent Columbia Slough or Smith/Bybee Lakes to study the interaction with the surrounding surface water. There was an attempt to place a second sensor at the bottom of the silt/clay layer to look at the vertical gradient in the silts. When possible, at least one sensor was placed at the top of the sand/gravel aquifer.

The piezometer data will be read as frequency, and converted to pressure (psi) using a polynomial expression (and calibration factors unique to each sensor, as obtained from the transducer manufacturer). Because the sensors are unvented, they will be adjusted for the atmospheric barometric pressure (primarily obtained from the Oregon Climate Center, and with gaps filled in from an on-site barometer).

Strategy 3: Address Specific Questions through Short-Term Investigations

Objective. This Strategy involves short-term investigations of groundwater quality or dynamics to address specific questions which may arise based on results and evaluations of the other three strategies, or otherwise to provide further information based on perceived data gaps. For example, this may take the form of interim sampling/analysis (*i.e.*, between scheduled sampling) at selected locations, as needed based on new information resulting from ongoing data evaluation or modeling. Scheduled sampling/analysis may be modified based on the findings of these investigations (*e.g.*, changes in the sampling schedule or analytes at particular locations).

Short-term investigation of groundwater quality or dynamics may also be warranted by changes in hydrologic conditions as a result of natural events such as flooding, or due to environmental management actions such as the prospective removal of the earthen dam at the east end of the North Slough.

Measurements and Locations. Monitoring measurements and locations will depend on the nature of the questions or objectives driving the investigation. Where investigation involves groundwater sampling and analysis, the sampling and analytical protocols and methods described in the S/A Plan will be followed. However, data evaluation strategies and procedures used in this Strategy may be different from those described under Strategy 1.

Section 2

Surface Water Quality Monitoring

Introduction

The Surface Water Quality Monitoring Plan for the Smith-Bybee Lakes Wildlife Area (SBWA) includes monitoring surface water in the lower Columbia Slough around St. Johns Landfill (SJLF) and boundary areas of the SBWA, and in the two lakes. The plan comprises the following:

- Objectives
- Regulations
- Factors Integral to Monitoring Design
- Monitoring Strategies
- Sampling and Analysis Plan (see Section 6)
- Table A: Monitoring Parameters
- Table B: Monitoring Station Inventory
- Table C: Sampling Schedule
- Table D: Objectives for Evaluation of High Frequency Monitoring Data
- Figure 1: Map of Monitoring Locations (see Appendix for Table and Figures)

Objectives

A fundamental goal of surface water monitoring within the SBWA is to characterize changes in water quality and conditions as a function of hydrologic cycles, including the daily tidal cycle and seasonal changes in water elevation. This characterization will provide a context for effectively evaluating long-term trends in surface water quality around St. Johns Landfill and in the SBWA generally, and answering short-term questions, related to the following objectives:

1. Identify locations and hydrologic conditions where specific contaminants or conventional water quality parameters may pose risk to beneficial use of surface waters within the SBWA, or to the health of the SBWA ecosystem, and/or exceed recognized standards or guidance levels established in Oregon Administrative Rules (OAR) for surface water quality for the Willamette Basin, including specific management plans (TMDLs) for the Lower Columbia Slough, and other water quality limited criteria for the Lower Columbia Slough and its North Slough arm;

2. Identify sources of surface water contaminants where feasible;
3. Facilitate decisionmaking related to hydrology management, and assess the effects of associated actions on surface water quality.

Four monitoring strategies will be implemented to provide a basis for evaluating monitoring data to meet plan objectives, including:

Strategy 1: Evaluate High Frequency Data for Trends: Surface water data will be collected at high frequency to characterize changes in water quality and conditions as a function of hydrologic cycles, by measuring conventional water quality parameters year-around at 3 strategically-located stations which are indicative of influences of Willamette River water and Columbia Slough water from points east of SBWA.

Strategy 2: Evaluate Low Frequency Data for Trends: Surface water data will be collected at low frequency to evaluate trends in water quality by measuring conventional water quality parameters (including biological) and dissolved metals, 6 times per year at 5 locations, which, when sampled in relation to the tidal cycle provide specific information about water quality impacts and trends within SBWA.

Strategy 3: Address Specific Questions through Short-Term Investigations: Specific questions will be addressed through short-term investigative monitoring. Questions may include, for example: stormwater outfalls and CSO events; runoff containing de-icing fluids used at Portland International Airport (PDX) during winter months; discharge of contaminated groundwater from St. Johns Landfill; accidental discharges or spills into the Slough or lakes.

Strategy 4: Evaluate the Effects of Hydrology Management: Evaluate short-term effects associated with hydrology management, including the aquatic habitat enhancement plan endorsed by the Smith-Bybee Lakes Management Committee.

Locations and parameters monitored under any of these strategies may change based on modification of plan objectives, or new goals developed for the monitoring program.

Regulations

The regulations listed below are applicable or potentially applicable to Metro's monitoring and management of surface water quality within SBWA, and are integral to the objectives described above.

Likely to take precedence is Section 303(d) of the Clean Water Act, which requires that the state (DEQ) establish Total Maximum Daily Loads (TMDL) (i.e. loading capacity for a given contaminant or stressor) for each waterbody identified by the state as failing to meet water quality standards. The Columbia Slough is one such waterbody. DEQ has set draft TMDLs for selected conventional water quality parameters and toxics in the Columbia Slough. Metro's ground water, surface water and storm water monitoring within SBWA will be used to assess compliance with TMDL standards and procedures where applicable.

Applicable regulations include:

- Solid Waste Disposal Site Closure Permit (i.e. requires that Metro ensure control of surface runoff and solid waste leachate seeps from SJLF to minimize discharges of pollutants into public waters)
- NPDES Stormwater Discharge General Permit (existing 1200-G type permit for landfills; proposed 1200-Z type general permit)
- Oregon Administrative Rules (Chapter 340: Division 41 -- Water Pollution (including surface water quality rules for the Willamette River Basin)
- Clean Water Act (Section 305(b)); designation of water quality limited surface waters
- Clean Water Act (Section 303(d)); Total Maximum Daily Load (TMDL) standards and procedures for the Columbia Slough

Factors Integral to Monitoring Design

Following are lists and summaries of factors that are reflected at varying extent throughout the plan. They are integral, or potentially integral considerations in the design of monitoring implementation strategies (measurements and locations), and will be incorporated as required into data evaluation.

Processes Affecting Surface Water Quality within SBWA

Following is a list of the various factors which affect surface water quality within SBWA, and which are reflected in the objectives and monitoring strategy.

- Columbia River and Willamette River seasonal peak and low-point elevations
- pumping from the upper Columbia Slough (Multnomah County Drainage District operations)
- daily tide cycle (which causes Willamette River water to flow in and out of the Columbia Slough)
- diurnal cycle (which affects oxygen production/demand by algae)
- rainfall
- flooding
- stormwater from surrounding land
- hydrology management
- sources and potential sources of contamination

Sources and Potential Sources of Surface Water Contamination within SBWA

A multitude of sources have contributed to contamination of surface waters within SBWA. Currently, the lakes are likely not impacted as directly by these sources as the Columbia Slough and its North Slough arm. However, the proposed removal of the existing dam at the east end of North Slough will return the lakes to the Columbia Slough system, and lake water quality is likely to become comparable to that of the lower Columbia Slough generally. Sources of contamination in SBWA include:

- storm water outfalls and other storm water runoff
- combined sewer overflows (CSO) *
- NPDES permitted waste water discharges
- DEQ-listed cleanup sites
- possible unpermitted discharges and unknown contaminated sites
- St. Johns Landfill
- Contaminants from the Willamette River and other areas of the Columbia Slough

* Through the City of Portland (BES) CSO Program, by 1999 Columbia Slough CSOs will be reduced to one winter event every 5 years, and one summer event every 10 years. By 2012, Willamette River CSOs will be reduced to 4 winter events, and one summer event every 3 years.

Hydrologic Cycles

Understanding hydrologic cycles is essential to understanding impacts and trends in surface water quality within SBWA, especially daily changes in water level and quality attributable to tides. Water level and flow in the Columbia Slough within SBWA is controlled predominantly by water level at the confluence with the Willamette River, which incorporates the effects of both the Willamette and Columbia rivers, including the daily tide effect. The twice daily tides cause Willamette River water to flow into and out of the Columbia Slough. In this regard, monitoring stations will be located for effective assessment of influences external to the SBWA, namely water from the Willamette River and points east in the Columbia Slough, including water pumped by the Multnomah County Drainage District from the upper Columbia Slough. These stations will also assess "internal" trends in water quality, which are assumed to be influenced both by external and internal sources and factors.

An essential consideration in surface water monitoring within SBWA is that water flow does not follow a typical river model. Rather, the area is a freshwater tidal "estuary" of the Willamette River, upon which tidal forces act twice daily, and where water from the Willamette River and Columbia Slough mix. Mixing occurs predominantly in the main channel of the Slough from its mouth up to approximately its eastern boundary within SBWA (i.e. North Portland Road bridge). Currently, mixing is negligible in the Slough east of North Portland Road bridge (approximately), as well as in its North Slough along the north flank of the SJLF.

In 1998, Smith and Bybee lakes are scheduled to be re-connected to the Columbia Slough system through replacement of the earthen dam at the east end of the North Slough with an open, water control structure. [see discussion below] When this occurs, tidal influence in both the North Slough arm and the lakes will become significant, and water quality in those areas will be largely influenced by Willamette River water. Wells (1995) estimated that at high tide, water entering North Slough and Bybee Lake will be predominantly Willamette River water. Currently, water input into the lakes is mainly precipitation and stormwater runoff.

Hydrology Management

Surface water data will be collected as required to facilitate decisions related to hydrology management and to assess the effects of actions associated with those decisions. In June, 1996, the Smith-Bybee Lakes Management Committee endorsed a phased approach to aquatic habitat enhancement within SBWA. This represents the primary hydrology management project which may require strategic monitoring of surface water.

The minimum action endorsed by the Committee included removal of the existing dam, which inhibits water interchange between the North Slough and the lakes, and replacing it with an open structure which has the ability to retain water. This option also includes the ability to augment water levels through pumping. The maximum action endorsed by the Committee encompassed the minimum option, and two additional features, including: 1) separating the western arm of Bybee Lake with an adjustable weir; and 2) connecting this arm directly with the Columbia Slough. Implementation of the minimum option alone will return the lakes to intertidal wetlands, including an increase in population and diversity of wetland plant and animal communities. The maximum option will be implemented, if and only after implementing the minimum option, and monitoring indicates the maximum option is needed.

Tidal mixing in the North Slough is currently low due to the existing dam. Therefore, until the dam is removed, monitoring in the North Slough near the dam will primarily serve to assess potential impacts of SJLF in the North Slough, and to provide baseline data for comparison to data collected after removal of the dam. Likewise, data collected in the lakes will provide "before and after" baseline data for each lake. After dam removal, water flow into and out of the North Slough and lakes is expected to be significant, and monitoring in relation to the tides will serve to assess the influence of Willamette River water in those areas (high tide sampling), and "net effect" of internal factors and various contamination sources, including SJLF (low tide sampling).

When the lakes are returned to wetlands, existing surface water sampling stations in the lakes may not be accessible by boat during the driest months. However, they will be sampled at times when they are accessible, as they may be indicative of the net effect of marsh water and river water, i.e., mixing at the approximate deepest areas of the Bybee and Smith units (see Strategy 2 under "Monitoring Strategies").

Another project whose impact must be monitored is water level management in the upper Columbia Slough conducted by the Multnomah County Drainage District. In recent years water levels in the upper Slough have been lowered from their historical level between 8 and 8.5 feet (mean seal level) to a level between 5 and 6 feet. The purpose of this drawdown was to reduce the residence time of the nutrient rich groundwater in the upper Slough, thereby reducing algae growth in the upper Slough.

The impact of the drawdown of the upper Slough on the lower Slough may be increased algae growth because of increased levels of dissolved phosphate coupled with the long travel time (approximately 5 days) from the east end of the lower Slough near Multnomah County Drainage District pump station #1 to the Willamette River. However, levels of phosphate in the upper and lower Slough have recently been reduced because of an increase in growth of macrophytes and associated attached algae in the Upper Slough. As a result suspended algae growth has also been reduced significantly. Because of these changes in management of the upper Slough, there is a need to monitor water quality entering the SBWA.

Hydrology Modeling

Although gathering surface water flow data and surface water modeling are not currently included in this plan, such information where available and applicable will be used to evaluate impacts and changes in surface water quality. Applicable resources for this type of information include, but are not limited to:

- USGS measurements of river stage (Willamette River and Columbia Slough)
- Wells, S.A. (1992) *Analysis of Management Alternatives for Improving Water Quality in North Slough Adjacent to the St. Johns Landfill*, Portland State University;
- Wells, S.A. (1992) *Assessment of Management Alternatives for Improving Water Quality in North Slough Adjacent to the St. John's Landfil*l, Portland State University;
- Wells, S.A. (1995) *Analysis of Flow Augmentation from Smith and Bybee Lakes on North Slough Dissolved Oxygen Conditions*, Portland State University;
- Wells, S.A. (1995) *Hydraulic Modeling of Opening Smith and Bybee Lake to the Lower Columbia Slough,* Portland State University;
- Baptista, A. (1994) *Computer Modeling and Scientific Visualization of the St. Johns Landfill Surface Water Environ,* Oregon Graduate Institute.

There is an important interplay between surface water and groundwater. For example, regional groundwater flow patterns are controlled by seasonal fluctuations in elevation of the Columbia and Willamette Rivers, and by variability in aquifer recharge by rain and surface water. In this regard, surface water dynamics influence groundwater contaminant fate and migration.

In 1995, a groundwater model of St. Johns Landfill and vicinity was developed for Metro by Portland State University (Li, Shuguang, *St. Johns Landfill Groundwater Modeling System: Predicting Leachate Mounding, Fluxes and Offsite Migration*). The model will provide important input to surface water monitoring/modeling for impacts of the landfill. [see below under "St. Johns Landfill"] It will use site hydrogeological data and groundwater monitoring data to predict rates and direction of groundwater and contaminant flow within the landfill and into the surrounding environment.

St. Johns Landfill

Surface waters within SBWA have been contaminated by multiple sources, and the nature of contamination varies with contaminant discharge rates, natural hydrologic cycles, and hydrology management. In this context, assessing the impact of St. Johns Landfill on surface water using surface water monitoring data is difficult. While there have been previous estimates of the impact of the landfill on surface waters -- most recently in the *Columbia Slough Water Body Assessment* prepared for the City of Portland (BES) in 1995 by CH2M HILL -- it is expected that the SJLF groundwater model will be the best tool to date for making these estimates.

Groundwater monitoring at SJLF is extensive and ongoing. Over the next year, the assumptions and inputs of the SJLF groundwater model will be reviewed. Groundwater data will be used in the model to estimate current and future potential discharge (of contaminants which are mobile in the aquifer) into surface waters of SBWA, and Metro will reassess its management strategy as additional information is gathered.

Monitoring Strategies

This section presents summaries of four surface water monitoring strategies. Each strategy addresses plan objectives using different but related strategies, and associated methods for sampling and analysis. Details related to these strategies are provided in Tables A through D, including monitoring parameters, monitoring station inventory, sampling schedule, and data evaluation objectives, respectively. The station inventory (Table B) provides a summarized listing of monitoring stations, including the importance of monitoring at the locations identified below.

Strategy 1: Evaluate High Frequency Data for Trends

Objective. Evaluate data collected at high frequency to assess changes in water quality and conditions as a function of hydrologic cycles (daily, seasonal), at 3 locations which are indicative of influences of Willamette River water and Columbia Slough water from points east of SBWA, due to the tidal cycle. This information will provide the context (i.e., regular variation associated with hydrologic cycles) for implementing Strategies 2 through 4, and evaluating results.

Method. Using field monitoring equipment, measure 5 conventional water quality parameters (pH, temperature, dissolved oxygen, specific conductance and redox) year-around, at intervals which fulfill data requirements of current objectives, at 3 locations including:

1. North Portland Road bridge -- indicative of dominant influence of points east (from SBWA) in the Columbia Slough system; may show some influence of Willamette River water at high tide.

2. Lombard Avenue bridge -- indicative of dominant influence of Willamette River.

3. East end of North Slough arm -- indicative of conditions in North Slough generally, including potential impacts of SJLF; provides "before" data (reflecting little tidal effect) for comparison to data collected after removal of the dam (significant tidal effect).

Similar data is currently collected by the City of Portland (BES) at Landfill bridge. This data will be utilized as needed to answer questions raised by the evaluation of data from the 3 stations described above. Data from Landfill bridge is indicative of a central point in a high tide "mixing zone" of Willamette River water and Columbia Slough water; at low tide, it is indicative of the influence of Columbia Slough water (points east).

Data Evaluation. Data collected through implementing Strategy 1 will be evaluated routinely to characterize changes in surface water quality associated with hydrologic cycles. This will involve time series graphing of data which is oriented toward identifying violation of water quality guidance values or standards -- including where and when violations occur, and the magnitude of the exceedence. Data evaluation objectives for this strategy are presented in Table D.

Strategy 2: Evaluate Low Frequency Data for Trends

Objective. Evaluate data for long-term trends in conventional water quality parameters (including biological) and metal concentrations, at locations which, when sampled in relation to the tidal cycle, provide specific information about water quality impacts and trends within SBWA.

Method. Grab sampling for field measurement of conventional water quality parameters, and for laboratory analysis of other conventionals including biological parameters, and dissolved metals; 6 times per year (see schedule in Table C) at 5 locations identified below. Flexibility has been incorporated into the schedule to allow for sampling in relation to observed changes in surface water conditions and dynamics.

Sampling will be conducted at low tide at all locations except one. Low tide sampling provides results which are less indicative of the influence of the Willamette River, and more indicative of the "net effect" of conditions and contamination which are internal (SBWA), external (from points east in the Columbia Slough), or both, depending on the monitoring location. Only the Lombard Avenue bridge will be sampled at high tide -- to provide data representative of Willamette River water entering SBWA.

1. Lombard Avenue bridge -- sampled at high tide; indicative of Willamette River water entering SBWA, including main channel Columbia Slough, North Slough arm and the lakes.

2. North Portland Road bridge -- indicative of dominant influence of points east (from SBWA) in the Columbia Slough system; may show some influence of Willamette River water at high tide.

3. East end of North Slough arm -- sampled at low tide; indicative of conditions in North Slough generally, including possible effects of SJLF; provides "before" data for comparison to data collected after removal of the dam; after removal, and when sampled at low tide, indicative of net effect of conditions and contaminants from lakes.

4. Bybee Lake -- representative of general water quality in Bybee lake (central location at approximate deepest point); after dam removal, when sampled at low tide, may be indicative of the net effect of marsh water and river water (i.e. mixing where water level is deepest within the "lake").

5. Smith Lake -- representative of general water quality in Smith lake (central location at approximate deepest point); after dam removal, when sampled at low tide, may be indicative of the net effect of marsh water and river water (i.e. mixing where water level is deepest within the "lake").

In addition, grab samples will be collected 3 times per year for measurement of the parameters described above, at two confined water bodies within SBWA, which provide important comparisons in evaluating external effects on the tidal-influenced lakes, and will provide useful supplemental information to the characterization of critical habitat characterization. These water bodies are referred to as Turtle Pond and Turtle Slough, and are located between the lakes on the Marine Drive side of the SBWA.

Water depth will be measured in conjunction with grab sample collection, as required, using staff gages.

Data Evaluation. Data collected through implementing Strategy 2 will generally be evaluated within the context of Strategy 1 data. Violations of water quality guidance values or standards, where applicable, will be identified as feasible within the context of changes in standard water quality parameters associated with hydrologic cycles as characterized in Strategy 1. This may include correlating selected parameters; for example, dissolved metals with pH and dissolved oxygen, and ammonia with pH and temperature.

Data collected under this strategy may also be evaluated in the context of estimated groundwater contaminant loading to surface waters from St. Johns Landfill. [see Groundwater Quality Monitoring Plan]

<u>Strategy 3: Address Specific Questions through Short-Term Investigations</u>

<u>Objective</u>. This strategy provides short-term investigative monitoring which addresses specific questions; for example:

- stormwater outfalls and CSO events;
- runoff containing de-icing fluids used at Portland International Airport (PDX) during winter;
- discharge of contaminated groundwater from St. Johns Landfill;
- accidental discharges or spills.

In addition to being protective of SBWA, monitoring under this strategy may generally facilitate a better understanding of water quality factors and issues in the lower Columbia Slough system.

<u>Method</u>. Monitoring methods are dependent on the nature of the question being addressed and associated objectives, which in turn may be dependent on hydrologic conditions. An example may be monitoring in the vicinity of stormwater outfalls within SBWA, as warranted based on the evaluation of data collected through Strategy 2; during the fall, winter and spring, samples could be taken at stormwater outfall, as feasible. Another example is monitoring associated with low dissolved oxygen (to supplement data collected in Strategy 1) during periods of below freezing temperature, due to biochemical oxygen demand of aircraft and runway de-icing chemicals used by PDX.

<u>Data Evaluation</u>. Data collected through implementing Strategy 3 will generally be evaluated within the context of Strategy 1 data. Violations of water quality guidance values or standards, where applicable, will be identified as feasible within the context of changes in standard water quality parameters associated with hydrologic cycles as characterized in Strategy 1. This will include correlating selected parameters as required.

Data collected under this strategy may also be evaluated in the context of estimated discharge of contaminated groundwater from St. Johns Landfill [see Groundwater Quality Monitoring Plan].

Strategy 4: Evaluate the Effects of Hydrology Management

Objective. Monitor for short-term effects associated with hydrology management, including the aquatic habitat enhancement plan endorsed by the Smith-Bybee Lakes Management Committee.

Method. Monitoring methods are dependent on the nature of the management action(s) involved and associated objectives, which in turn may be dependent on hydrologic conditions.

In the case of replacing the existing dam with an open structure, monitoring may include short-term measurement of conventionals (including nutrients and biological) on either side of the existing dam, prior to dam removal; followed by short-term monitoring in those same locations after removal. The timing and duration of this sampling would be determined based on objectives to be defined. It may require coordination with sediment monitoring, in order to make a more informed assessment of water quality effects of the implemented action.

In certain cases, measuring selected water quality parameters, (e.g., nutrients, chlorophyll or algal biomass) at particular locations and times may guide or evaluate decisions regarding water containment or pumping.

Data Evaluation. Data collected through implementing Strategy 4 will generally be evaluated within the context of Strategy 1 data. Violations of water quality guidance values or standards, where applicable, will be identified as feasible within the context of changes in standard water quality parameters associated with hydrologic cycles as characterized in Strategy 1; particularly, as the influences of those cycles are altered by hydrology management actions.

Section 3

Sediment Quality Monitoring

Introduction

The Sediment Quality Monitoring Plan for the Smith-Bybee Lakes Wildlife Area (SBWA) includes monitoring of sediment in the lower Columbia Slough around St. Johns Landfill and in Smith and Bybee lakes. The plan comprises the following:

- Objectives
- Regulations
- Factors Integral to Monitoring Design
- Monitoring Strategies
- Sampling and Analysis Plan (see Section 6)
- Sampling and Analysis Plan
- Table A: Monitoring Parameters
- Table B: Monitoring Station Inventory
- Table C: Sampling Schedule
- Figure 1: Map of Monitoring Locations (see Appendix for Tables and Figures)

Objectives

The overall goal of the sediment monitoring plan is to characterize sediment quality within the Smith-Bybee Lakes Wildlife Area to address the following objectives.

1. Identify those locations and conditions where sediment contaminants pose risk to beneficial use of surface waters within the SBWA, or to the health of the SBWA ecosystem, and/or exceed standards (where standards are available and applicable);

2. Identify sources of those contaminants where feasible;

3. Facilitate decision making related to environmental enhancement projects (e.g., aquatic habitat enhancement through hydrology management), and assess the effects of associated actions on surface water quality.

Sediment quality monitoring is complicated by an array of processes (physical, chemical and biological) which are interrelated and complex, and strongly influence sediment contaminant levels and toxicity. While the plan cannot reasonably characterize these processes for sediments within the SBWA, it will take them into consideration to the extent feasible and necessary. It is recognized that a basic understanding of them is required to achieve plan objectives.

Six monitoring strategies will be implemented to provide a basis for evaluating monitoring data to meet plan objectives, including:

Strategy 1 (Evaluate Short-Term impacts and Long-Term Trends): Sediment data will be collected and evaluate for short-term impacts and long-term trends in sediment quality at 7 strategically-located stations, mainly around SJLF.

Strategy 2 (Evaluate the Effects of Stormwater Outfall into the Lakes): Sediment data will be collected and evaluated for possible impacts on lake sediment quality of the five primary stormwater outfalls from the Marine Drive area of SBWA.

Strategy 3: Evaluate the Effects of Stormwater from SJLF: Sediment data will be collected and evaluated for possible impacts on sediment quality in 2 areas of Smith Lake near stormwater outfall from St. Johns Landfill (SJLF).

Strategy 4: Evaluate Benthic Communities in Monitored Sediments: Benthic communities in monitored sediments will be characterized using selected biological indices.

Strategy 5: Evaluate the Effects of Hydrology Management: Sediment data will be collected and evaluated for the effects of hydrology management actions on sediment quality

Strategy 6: Address Specific Questions through Short-Term Investigations: Specific questions will be addressed through short-term investigative monitoring. For example, questions may relate to accidental spills/runoff of industrial chemicals.

Locations and parameters monitored under any of these strategies may change based on modification of plan objectives, or new goals developed for the monitoring program.

Regulations

There are currently no directly applicable state or federal standards for freshwater sediment quality. [see "Lack of Sediment Standards" below under "Discussion of Key Considerations"]

Factors Integral to Monitoring Design

Following are lists and summaries of factors that are reflected to varying extent throughout the plan. They are integral, or potentially integral considerations in the design of monitoring implementation strategies (measurements and locations), and will be incorporated as required into data evaluation.

Processes Affecting Sediment Quality, Quantity and Transport

- water inflow and outflow associated with daily tidal cycle, and Columbia River and Willamette River seasonal peak and low-point elevations
- land use practices such as impervious surfaces and erosion control/prevention
- rainfall
- stormwater carrying sediment from surrounding land
- hydrology management
- sources and potential sources of contamination
- deposition and resuspension in the lakes caused by wind

Sources and Potential Sources of Sediment Contamination in SBWA

- stormwater outfalls and other stormwater runoff
- combined sewer overflows
- NPDES permitted waste water discharges
- DEQ-listed cleanup sites
- possible unpermitted discharges and unknown contaminated sites
- St. Johns Landfill
- contaminants from the Willamette River and other areas of the Columbia Slough
- deposition of airborne contaminants (atmospheric fallout)

Beneficial Uses of Surface Waters in SBWA

DEQ has identified the entire Columbia Slough to be waters of the state, with all the designated beneficial uses applicable. OAR 340-41-442 lists the following beneficial uses for Willamette River tributaries:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Anadromous Fish Passage
- Salmonid Fish Rearing
- Salmonid Fish Spawning
- Resident Fish and Aquatic Life

- Wildlife and Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality
- Hydropower

Beneficial uses for public and private domestic water supply assume adequate pre-treatment and natural water quality that meets drinking water standards.

Some of the listed beneficial uses do not apply to the Columbia Slough, including anadromous fish passage, salmonid fish rearing and spawning, and hydropower. Beneficial uses of the Columbia Slough are affected by a variety of factors, such as land use, habitat, hydrology, channel morphology, and prevailing water quality conditions. Because water quality criteria were developed with the intent of protecting designated beneficial uses, violations of these criteria are important indicators of negative impacts on beneficial uses. Violation determinations will be conducted within the surface water component of the SBWA Environmental Monitoring Plan. However, to the extent that surface water quality is affected by sediment quality, the sediment monitoring plan will evaluate the role of sediment quality in such violations, as necessary and feasible.

Past and Ongoing Sediment Monitoring

Columbia Slough Sediment Project (BES). In 1994-95, as part of the Columbia Slough Sediment Project, BES conducted a study assessing risks to human health and the ecosystem at some 300 sediment sampling sites in the Columbia Slough, including some 66 sites within the SBWA. As part of this study, Metro conducted a screening level risk assessment of the SBWA, including risks posed by sediments.

The BES Study combined risks to human health, aquatic life and wildlife into overall hazard ranking scores for each of the 300 sites. The scores were ranked into 4 classifications: "A" indicates sites that pose the highest relative risks, while "D" indicates the least risk. One of the 10 "A" sites was within SBWA just west of Landfill Bridge near CSO outfall no. 54. Two of 24 "B" sites were within SBWA; one close to the "A" site near Landfill bridge, and the other at about mile 4.0 of the Lower Slough, near the southeast corner of Smith Lake.

Risks posed by sediments within SBWA were comparable to those in other areas of the Columbia Slough system, and were primarily risks to benthic organisms from uptake of sediment contaminants. Risks to humans and other aquatic life from exposures to sediment were estimated to be low.

Beginning in 1995, BES initiated "Early Action Remedial Activities" within the Columbia Slough system, based on risks assessed in the first phase of the Columbia Slough Sediment Project. These activities included detailed risk evaluation at areas of concern where site characteristics were favorable for source identification, including the Wapato Wetland adjacent to the SBWA. The Wapato Wetland Risk Evaluation included limited sediment sampling in the "Blind Slough" near SJLF.

The Columbia Slough Sediment Project is ongoing, and where data from this project are applicable to the SBWA Environmental Monitoring Program, they will be used if feasible.

Historical Sediment Data. During the 1970s and 1980s, several projects were conducted in the Lower Columbia Slough which included sediment sampling. Data from the projects which focused on the SBWA are contained in Metro's Environmental Monitoring Information System (EMIS) database. These projects include:

- Fishman Environmental Services, 1987. *Smith and Bybee Lakes Environmental Studies*. Prepared for the City of Portland (BES).
- Fishman Environmental Services, 1989. *Columbia Slough Planning Study Background Report*. Prepared for the City of Portland (BES).
  Sweet-Edwards/EMCON, 1989. *St. Johns Landfill Water Quality Impact Investigation and Environmental Management Options*. Prepared for Metro.
- Ecology and Environment Inc., 1990. Fuel Processors site sediment data. Prepared for Oregon DEQ.

Note that the Ecology and Environment study focused on the vicinity of the property of Fuel Processors (formerly Merit Oil USA), which is located on North Suttle Road near the northeast shore of Smith Lake. Sediment samples collected as part of this study were from Smith Lake and a drainage ditch through which stormwater entered the lake.

Sediment samples collected in the other studies listed were from the Columbia Slough, including its North Slough arm, and Smith and Bybee lakes.

Where it is determined that this historical data will facilitate evaluation of new data to address plan objectives, those data will be used as feasible.

Potential Major Sources of Sediment Contamination

Combined Sewer Overflows. There are 13 combined sewer overflows (CSOs) in the Lower Columbia Slough, including 3 within SBWA. Although bacteria are the primary concern with CSOs, it is generally recognized that CSOs have affected sediment quality in the Lower Columbia Slough through discharge of other pollutants which may settle into Slough sediments (e.g., heavy metals).

Because of the tidal effect within SBWA, sediments within SBWA may also be affected by CSOs in the Willamette River, several of which are located in the St. Johns area, and many more upstream. However, the extent of this impact, if any, is an unresolved function of contaminant type and complex hydrologic conditions.

CSOs are regulated under the NPDES program, and a 1994 agreement between DEQ and the City of Portland. Under the agreement, CSOs will effectively be removed by the City from the Columbia Slough by December 1, 2000. By 1999, Columbia Slough CSOs will be reduced to one winter event every 5 years, and one summer event every 10 years. By 2012, Willamette River CSOs will be reduced to 4 winter events, and one summer event every 3 years.

To the extent feasible, the plan will evaluate trends in sediment quality which may be related to this reduction in CSOs.

Nonpoint Source Runoff. Stormwater runoff from nonpoint sources is a major source of water for the Columbia Slough and Smith and Bybee Lakes, particularly during winter months. Contaminants in this runoff typically include nutrients and fecal coliforms, total suspended solids, metals and biochemical oxygen demand (BOD). These contaminants and others are a primary source of surface water and sediment quality problems. Sources of runoff within SBWA which may introduce contaminants include railroad beds, scrap metal yards, and assorted industries (e.g., on North Suttle Road along Smith Lake).

St. Johns Landfill. Surface water sediments within SBWA have been contaminated by multiple sources, and the nature of contamination varies with contaminant discharge quantities and rates, sediment characteristics and dynamics, natural hydrologic cycles, and hydrology management. In this complex matrix of factors, the contribution of the landfill to contamination of sediments in surrounding surface waters is difficult to ascertain. Data collected from some of the sediment monitoring stations identified in this plan may be indicative of the impacts of SJLF, although distinguishing these impacts from those caused by other sources will generally not be possible from a simple review of laboratory results for sediment samples.

Assessing contaminant loading from SJLF to sediments in the surrounding environment, and associated risks, requires inputs from groundwater monitoring (refer to Groundwater Quality Monitoring Plan), including: educated estimates of groundwater contaminant discharge into surface waters surrounding SJLF (approximate location and rate of discharge, both for the highly mobile constituents of existing seepage, and future predicted discharge for selected contaminants based on estimated retardation factors); estimated ambient concentrations in a surface water mixing zone, if any, based on applied dilution and dispersion factors; estimated contaminant deposition to sediment within this mixing zone. A fugacity model may be required to estimate partitioning into surface water, sediment, and air, of contaminants discharged from groundwater.

Hydrologic Factors

Water level and flow in the Columbia Slough within SBWA is controlled predominantly by levels at the confluence with the Willamette River, which incorporates the effects of both the Willamette and Columbia rivers, including the daily tide effect. In 1998 (tentatively, August or September), Smith and Bybee lakes will be re-connected to the Columbia Slough system through replacement of the earthen dam at the east end of the North Slough with an open, water control structure. When the dam is replaced, tidal influence in both the North Slough and the lakes will become significant, and sediment quality in those areas may become influenced by flow from North Slough.

The influence of hydrologic cycles on sediment quality within SBWA is not included in this plan, as that influence is suspected to be generally small. However, the effect of hydrologic cycles on water elevation along of the perimeter of the lakes where monitoring stations are located will be taken into consideration. Removal of the North Slough/Bybee Lake dam will change the lakes into a tidal marsh wetland. It is expected that water will recede annually in summer and early fall, leaving sediments exposed as mudflats at a number of sediment sampling stations. This seasonal change in the sediment environment will likely affect the types and levels of contaminants at those locations, and will be considered in data evaluation.

Sediment Quality Criteria and Standards

The factors summarized below are essential considerations in monitoring and assessing sediment quality. Two broad conclusions may be drawn from these summaries: 1) sediment contaminant levels and toxicity are the result of a complex interplay of physical, chemical and biological factors; and 2) total contaminant levels in sediments are not generally correlated with sediment toxicity, but are just one factor contributing to toxicity.

Sediment Characteristics and Dynamics. The plan does not attempt to characterize complex physical, chemical and biological processes in sediments, but considers them to the extent feasible and necessary in sampling and data evaluation. Some of these processes are: the deposition, mixing and resuspension of contaminants; the transformation and complexation of chemicals; bacterial degradation of organic matter, and bioturbation. Bioturbation is the sum of biological activities which affect contaminant flux between sediment and water column, as well as the redistribution of chemicals within the sediment.

Pore Water and Metal Speciation. Interstitial or pore water surrounds sediment particles. Solutes in pore water, including contaminants, are generally bioavailable to benthic organisms. Contaminants adsorbed to or complexed with sediment particles are typically much less bioavailable. This distinction is important in assessing the effects and risks posed by sediment contaminants.

In addition to the adsorption, precipitation, and complexation processes discussed below, metal concentrations in pore water are controlled by pore water composition and metal speciation. Metal speciation is determined by redox intensity and capacity, which are often a function of microbial activity. For some metals, toxicity varies with valence. For example, chromium (+6) is reportedly one thousand-fold more toxic than chromium (+3), because of weaker interaction with particles and greater solubility. Predicting changes in metals speciation is therefore important in assessing risk and potential effects, and will be taken into consideration where necessary and feasible.

Analysis of whole sediment and pore water provide useful information in evaluating sediment quality, and are both considered to be monitoring tools of the plan. Because bioavailability is a key issue in assessing toxicity and risks to benthic organisms, analysis of pore water ultimately has greater utility.

Contaminant Binding. Metals and organic contaminants typically bind to solid phases in sediments. These bound contaminants may not be bioavailable (i.e., available for uptake by benthic organisms or aquatic organisms generally), and therefore may not be toxic. The primary binding phases of sediment are acid volatile sulfides (AVS) and total organic carbon (TOC). AVS are sulfide minerals which are extracted from sediment. Metals adsorb to organic sediment particles, and are precipitated by AVS in the form of sulfide solids.

Because of this complexation and precipitation, contaminant concentrations are not a direct indicator of toxicity. The amount of free or unbound contaminants is a better measure of toxicity. If sufficient "binding capacity" is provided by the combination of AVS and TOC, contaminants in the sampled sediment may pose no toxicity to benthic or other aquatic organisms. However, if the contaminant binding capacity is exceeded by the concentration of contaminants, the sediment is expected to be toxic in proportion to the excess contaminants that are unbound and therefore available in the pore water. A clear example of this is metals and AVS. Metals that are solubilized during the AVS extraction are referred to as simultaneously extracted metals (SEM). Where the molar ratio of SEM to AVS is less than one, metals are probably not bioavailable. If the ratio is greater than one, the excess metals may be bioavailable.

In additional to AVS and TOC concentration, the size distribution of sediment particles also influences contaminant speciation. Finer sediment particles (i.e., silts and clays) often correlate with higher contaminant concentrations because of their greater capacity for adsorption of contaminants compared to sand.

To adequately account for sediment contaminant levels and toxicity, the plan includes routine measurement of grain size, AVS and TOC, and possible increased monitoring where binding capacity of measured contaminants appears to be exceeded.

Biological Testing. Measurement of benthic community composition and relative abundance (and derived biological indices) will be performed at all sediment monitoring stations as part of the plan (see Monitoring Strategy 4). In addition, where chemical data evaluation indicates that contaminant levels may warrant concern, benthic community analysis and bio-toxicity testing may be required to verify the evaluation. Toxicity tests directly measure the effects on benthic organisms of sediment and pore water.

Lack of Sediment Standards. The complexities of sediment biology and dynamics have hindered the setting of standards for freshwater sediments. There are currently no specific sediment quality standards or guidelines in Oregon rules. EPA is in the process of establishing Sediment Quality Criteria (SQC) for the protection of benthic organisms. The SQC have initially been limited to 5 organic chemicals, including 3 polynuclear aromatic hydrocarbons -- acenaphthene, phenanthrene, fluoranthene, and two pesticides -- dieldrin and endrin. In addition to these, EPA is planning to develop SQC for additional nonionic organic chemicals, metals and ionic organic chemicals. Criteria are currently being developed for 5 metals, including cadmium, copper, lead, nickel, and zinc; and in a later phase of the process -- arsenic and chromium. The approach being used by EPA to derive sediment criteria for these metals relates the bioavailability of metals to acid volatile sulfide (AVS) concentration and organic binding phases (expressed as total organic carbon) in sediment.

Oregon is unlikely to strictly adopt EPA's SQC because of the site specific nature of sediment contaminant effects. DEQ is reviewing the so-called "Ontario Standards," as a possible screening mechanism for sediment quality. Developed in Canada, these standards define 3 levels of chronic long-term effects on benthic organisms and set concentration criteria for over 50 chemicals and compounds. Initially, the Ontario Standards will be used by Metro to the extent possible in evaluating data collected through this plan.

Monitoring Strategies

This section summarizes 6 sediment monitoring strategies. Each strategy addresses a different monitoring objective. Because monitoring objectives are interrelated, there will be connections among the monitoring strategies. Details of these strategies are provided in Tables A, B and C, including monitoring parameters, monitoring station inventory, and sampling schedule, respectively. The station inventory (Table B) provides a summary of monitoring stations, including the importance of monitoring at the locations identified below, and should be used with reference to Figure 1 (map showing locations).

Unless indicated otherwise, the sediment samples described in this section will be surficial grab samples (i.e., 0-10 centimeters depth), as this collects from the most biologically-active layer. Where surficial samples show contaminants and toxicity at levels of concern, sampling at greater depth (i.e., core sampling) may be pursued to determine the full extent of contamination.

Strategy 1: Evaluate Short-Term impacts and Long-Term Trends

Objective. The objective of this strategy is to determine short-term impacts and long-term trends in sediment quality in SBWA. This objective will be addressed by monitoring sediment quality at 7 locations within SBWA to, including the changing nature of risk posed by sediment contaminants.

Sediment quality will be evaluated in terms of chemical contamination, standard sediment quality parameters, and benthic community characteristics.

Measurements. The following parameters will be measured annually: grain size distribution, total organic carbon, total solids, acid volatile sulfides and simultaneously extracted metals, total metals, selected pesticides and herbicides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons (Table A).

Locations. One grab sample will be collected annually from each of the following locations. These locations were chosen because they are:

- near SJLF including proximity to landfill stormwater outfalls;
- near critical management areas;
- otherwise representative of sediment quality for larger areas within SBWA.

The specific significance of each sampling location follows the name of the location.

1. Bybee Lake -- central location at approximate deepest point; representative of sediment quality in Bybee lake; after dam removal, may be indicative of net effects on sediments of mixture of tidal marsh and river water.

2. Smith Lake -- central location at approximate deepest point; representative of sediment quality in Smith lake; after dam removal, may be indicative of net effects on sediments of mixture of tidal marsh and river water.

3. North Slough (east) -- under SJLF stormwater outfall R-5; helps assess the role of the outfall in sediment quality; critical hydrology management area; located between existing dam and prospective location of new water control structure (see Strategy 4 below).

4. North Slough (west) -- under SJLF stormwater outfall R-2; helps assess the role of the outfall in sediment quality.

5. North Slough (central) -- equidistant from North Slough east and west stations near small outcrop on landfill side of North Slough; facilitates evaluation of overall sediment quality in the North Slough.

6. Landfill bridge -- approximately 100 feet west of bridge under CSO #54; highlighted by Columbia Slough Sediment Project as relatively high risk site for sediment-dwelling organisms.

7. Blind Slough -- near terminus of the reach; highlighted in previous studies for sediment contamination.

Strategy 2: Evaluate the Effects of Stormwater Outfall into the Lakes

Objective. The objective of this strategy is to obtain specific information about the sediment quality impact, contribution to overall contamination, and long-term trends near 5 stormwater outfalls entering Smith and Bybee Lakes. The potential impact on sediment quality of deteriorating stormwater quality resulting from commercial development in the area will be evaluated.

When sampled at the end of the wet season, data from the stormwater outfalls described below will be indicative of the net effect on sediment quality at those locations, of annual stormwater discharges as well as cumulative, long term effects.

Measurements. The following parameters will be measured annually: grain size distribution, total organic carbon, total solids, acid volatile sulfides and simultaneously extracted metals, total metals, selected pesticides and herbicides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons (Table A). These will be sampled in June at the end of the wet season when most of the year's stormwater runoff has occurred. Three grab samples will be collected in a linear transect extending into the lake from each outfall. Spacing of the three samples will be 25, 50, and 100 feet from the outfall. Where the first sample cannot be collected 25 feet from the outfall, because of shoreline deadwood and debris, distances of approximately 50, 100 and 200 feet will be employed.

Locations. Samples will be collected annually from each of the following locations. These locations were chosen because they are the largest stormwater outfalls draining commercial properties along and near Marine Drive:

The specific significance of each sampling location follows the name of the location.

1. Marine Drive (west) outfall -- catchment includes commercial properties along Marine Drive, south of the Union Pacific railway, discharging through a culvert into the eastern lobe of Bybee Lake.

2. Marine Drive (east) outfall -- catchment includes commercial properties along Marine Drive, south of the Union Pacific railway, discharging through a culvert into a pond situated along Marine Drive between the two lakes.

3. Ledbetter Road outfall -- catchment includes commercial properties along Ledbetter Road, which runs west off Marine Drive, discharging through a catchment basin and manhole, then through a side slough into the western lobe of Bybee Lake.

4. Marine Drive (overpass) outfall -- catchment is the Marine Drive railways overpass, discharging through a small catchment basin, and a culvert into Smith Lake.

5. Suttle Road outfall -- catchment includes commercial industries along Suttle Road, discharging through a small wetland situated between Suttle Road and the closed section of Marine Drive; then, depending on the volume of stormwater, through a culvert into Smith Lake.

Strategy 3: Evaluate the Effects of Stormwater from SJLF

Objective. An engineered stormwater system for SJLF directs stormwater runoff from the landfill through a series of perimeter drainage pipes, sedimentation basins and culverts, discharging into the Columbia Slough, including the North Slough arm, and a marsh perimeter along the western corner of Smith Lake. This strategy aims to assess sediment quality in Smith Lake near two stormwater outfalls from the landfill. Historically, stormwater contaminated by solid waste was known to have discharged into one of these areas (from outfall R-7; see below), and may have discharged into the other. Data collected here will provide information about past and present impacts of runoff on sediment quality, possible trends in sediment quality, and the potential contribution of runoff to overall contamination of the lakes.

Note that sediment quality monitoring near stormwater outfalls from the landfill into the Columbia Slough and North Slough arm is not included in this strategy, and instead are covered by Strategy 1 above. The sediments of the main channel of the Columbia Slough will not be monitored for stormwater impacts because of complexities associated with surface water flow dynamics and contaminant dispersion, transport and deposition.

Measurements. Annual measurement of the following parameters: grain size, total organic carbon, total solids, acid volatile sulfides (and simultaneously extracted metals), total metals, selected pesticides and herbicides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons (Table A); sampled in June at the end of the wet season when most of the year's stormwater outfall has occurred. Three samples will be collected in a linear transect from each outfall at distances of approximately 25, 50 and 100 feet, respectively, from the respective outfall.

Locations. Samples will be collected annually from each of the following locations.

1. SJLF stormwater outfall (R-7) -- catchment is near the middle of the east flank of SJLF, discharging through a culvert into the marshy perimeter of Smith Lake.

2. SJLF stormwater outfall (R-21) -- catchment is near the southern end of the east flank of SJLF, discharging through a sedimentation basin and a culvert into the marshy perimeter of Smith Lake.

<u>Strategy 4: Evaluate Benthic Communities in Monitored Sediments</u>

<u>Objective</u>. The objective of this strategy is to characterize the health of benthic communities at selected monitoring stations, thereby providing a ecological context for the evaluation of chemical contaminant data, and physical data such as sediment grain size. Differences in benthic communities among locations within SBWA will be assessed.

<u>Monitoring Measurements and Locations</u>. Benthic infauna will be characterized at all monitoring stations included in Strategies 1 and 3, and 2 stations in Strategy 2 -- one in the main channel of the Columbia Slough, and one in the North Slough. Characterization will involve taxanomic classification, including bioindices such as species composition, relative abundance, and community composition. At stations where a 3-sample transect is involved, a sample will be collected closest to the source of interest -- *e.g.*, stormwater outfall.

Follow-up to this characterization will be determined based on a review of the bioindices, chemical and physical data for each location, relative to other locations, and would be performed under Strategy 6 (i.e., short-term, investigative monitoring to address specific questions). Such follow-up may involve further benthic community analysis, or bio-toxicity testing. Toxicity tests would be used to measure directly the effects on benthic organisms of sediment and pore water.

<u>Strategy 5: Evaluate the Effects of Hydrology Management</u>

<u>Objective</u>. The objective of this strategy is to identify changes in sediment characteristics associated with hydrology management, including the aquatic habitat enhancement plan endorsed by the Smith-Bybee Lakes Management Committee.

<u>Measurements and Locations</u>. Monitoring measurements and locations depend on the hydrology management action. For example, when the existing dam is replaced with an open water control structure, short-term measurement of sediment quality will be performed on both sides of the existing dam prior to its removal, to serve as a baseline of existing conditions. This will be followed by short-term measurements in those same locations after removal.

The results of this short-term monitoring will be evaluated in the context of results from scheduled monitoring of other sediment sampling locations, primarily those in the North Slough and the Lakes; and also in the context of surface water quality monitoring, which includes a comparable strategy for measuring the effects of hydrology management. Coordination with surface water monitoring is considered essential for making an more informed assessment of sediment quality effects of an implemented action.

Wherever a hydrology management action is implemented, and is expected to affect change is water quality, this "before and after" monitoring procedure will be employed in generally the same manner as described above, at respective critical locations. The exact timing and extent of sampling will depend on objectives of the hydrology management action.

Strategy 6: Address Specific Questions through Short-Term Investigations

Objective. The objective of this strategy is to address specific questions related to extreme or episodic events, such as flooding or unusual volume of stormwater outfall, or accidental spills of industrial materials. Monitoring under this strategy may also serve as a follow-up to unusual biological test results, or in conjunction will risk assessments where additional data is required.

Measurements and Locations. Monitoring measurements and locations will depend on the type of event and the information desired. For example, where a known spill and runoff of toxic material into surface waters within SBWA has occurred, sediment grab sampling and analysis for the appropriate chemical class may be performed; biological monitoring may also be performed. In this example, or other events where timely response is required, sampling will be performed as soon after the event as possible.

Section 4

Stormwater Quality Monitoring

Introduction

The Stormwater Quality Monitoring Plan for St. Johns Landfill (SJLF) includes monitoring of stormwater at several outfalls from the landfill into the Columbia Slough, including its North Slough arm, and Smith Lake. The plan comprises the following:

- Objectives
- Regulations
- Factors Integral to Monitoring Design
- Monitoring Strategies
- Sampling and Analysis Plan (see Section 6)
- Table A: Monitoring Parameters
- Table B: Monitoring Station Inventory
- Table C: Sampling Schedule
- Figure 1: Map of Monitoring Locations (see Appendix for Tables and Figures)

Objectives

Stormwater discharges are a major source of water for the Columbia Slough and Smith and Bybee Lakes, particularly during winter months. Contaminants in these discharges typically include nutrients and fecal coliforms, total suspended solids, metals and biochemical oxygen demand (BOD). These contaminants and others are a primary source of surface water quality problems.

The fundamental objective of stormwater monitoring for SJLF is to characterize the contribution to these problems, if any, of stormwater discharged from the landfill. Where monitoring shows contaminant levels to be lower in stormwater than surrounding surface water, a positive effect on surface waters (i.e. contaminant dilution) is also possible, particularly where stormwater volumes are high.

To achieve this objective, 3 monitoring strategies have been designed. [see "Monitoring Strategies"] These strategies address the requirements and guidance of two regulatory mechanisms: [see "Regulations"]

1. National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge General Permit for St. Johns Landfill; issued and enforced by the Oregon Department of Environmental Quality (DEQ).
2. State of Oregon regulations for surface water quality, including Oregon Administrative Rules (OAR) applicable to the Willamette River basin (OAR 340-41-442); and Total Maximum Daily Loads (TMDLs) for surface waters -- such as Columbia Slough -- which have been classified by DEQ as water quality limited under the Clean Water Act.

The three strategies are described below:

Strategy 1: Evaluate Compliance with Stormwater Discharge Permit: Stormwater data will be collected and evaluated for compliance with requirements of a prospective revised Stormwater Discharge General Permit (1200-Z type), proposed in 1996 by DEQ to the Environmental Protection Agency (EPA). [see section: "Review of Stormwater Discharge Permit Conditions"] However, until the revised permit is issued, monitoring will continue to be performed in accordance with the existing permit. Strategy 1 will be modified as necessary based on the version of the revised permit which is eventually approved by EPA.

Strategy 2: Evaluate Compliance with Surface Water Regulations: Stormwater data will be collected and evaluated to address state water quality regulations, primarily including monitoring requirements associated with the implementation by the City of Portland of DEQ-established TMDL standards (i.e. loading capacity for a given contaminant or stressor) for the Columbia Slough; and secondarily, possible future direction from DEQ for stormwater monitoring designed to meet OAR for surface water quality.

Strategy 3: Address Specific Questions through Short-Term Investigations: Specific questions will be addressed through short-term investigative monitoring. For example, questions may related to ongoing operations and maintenance, and vegetation management projects, as well as any incidents which may arise. The results of monitoring performed under the objectives of this strategy will also be used to address the regulatory objectives of Strategies 1 and 2, as necessary.

Locations and parameters monitored under any of these strategies may change based on modification of plan objectives, or new goals developed for the monitoring program.

Regulations

The regulations listed below are applicable to Metro's monitoring and management of stormwater quality at SJLF, and are integral to the objectives described above.

- Solid Waste Disposal Site Closure Permit (i.e. requires that Metro ensure control of surface runoff and solid waste leachate seeps from SJLF to minimize discharges of pollutants into public waters).

- NPDES Stormwater Discharge General Permit (existing 1200-G type permit for landfills; proposed 1200-Z type general permit)
- OAR 340-41 -- Water Pollution (including surface water rules, e.g. for Willamette River Basin)
- Clean Water Act (Section 305(b)); designation of water quality limited surface waters
- Clean Water Act (Section 303(d)); Total Maximum Daily Load (TMDL) Standards and Procedures

The existing Stormwater Discharge Permit for SJLF (1200-G general permit) includes specific monitoring requirements for sampling frequency, locations and parameters, discharge limits for specified parameters, and reporting format and schedule. The permit also infers any stormwater monitoring necessary to meet state regulations for surface water quality -- including monitoring of TMDL parameters where receiving waters are water quality limited -- but provides no monitoring specifications. This is the permit which is currently being revised by DEQ. [see section: "Review of Stormwater Discharge Permit Conditions"]

All receiving surface waters for stormwater discharge from SJLF have been classified by DEQ as water quality limited under Section 305 of the Clean Water Act, meaning they have failed to meet state water quality standards -- in this case, for the Willamette River Basin; they include the Columbia Slough and its North Slough arm, and Smith and Bybee Lakes. Under Section 303 of the Act, DEQ is establishing TMDLs for the Columbia Slough.

Factors Integral to Monitoring Design

Following are lists and summaries of factors that are reflected to varying extent throughout the plan. They are integral, or potentially integral considerations in the design of monitoring implementation strategies (measurements and locations), and will be incorporated as required into data evaluation.

Processes Affecting Stormwater Quality and Quantity

Various factors affect SJLF stormwater quality, including natural factors (e.g. rainfall) and various activities performed on the landfill, whether ongoing or special projects. These factors may alter the nature of stormwater quality through mechanisms such as dilution or the addition of suspended solids; they may also introduce pollutants to stormwater. They are reflected in the objectives and methods (see section: "Monitoring Strategies") of this plan, and include but are not limited to the following:

- rainfall
- snowfall
- flooding

- ongoing operations and maintenance (including landfill gas and leachate collection systems)
- vegetation management projects
- recreational development projects
- sheep grazing
- waterfowl grazing

In 1996 all elements of the cover system for St. Johns Landfill (SJLF) were completed, including the gas collection and stormwater systems. Post-closure maintenance will be performed routinely on mechanized systems for collecting gas, condensate and leachate (for discharge to sanitary sewer), and stormwater (for discharge to surface water). Disturbance or breaks in these systems could potentially impact stormwater quality, and monitoring procedures of this plan will take them into consideration.

Within the next year, the equipment maintenance building/yard will be moved from the landfill across the Columbia Slough to "Parcel A," situated between the Columbia Slough and Columbia Boulevard. This will remove potential contamination of stormwater by lubricants and cleaners, etc., which are associated with maintenance of vehicles and other equipment.

A vegetation management plan for SJLF is currently being implemented. A principal goal of the plan is to stabilize the landfill surface with native vegetation. While native vegetation is establishing, topsoil may be exposed in certain areas of the landfill for periods of time. For example, native bunch grass seeded on the landfill grows in clusters which take a relatively long time to form dense cover. When native bunch grass replaces a non-native grass which forms a dense cover, loading of suspended solids in stormwater and receiving surface waters may increase. Total suspended solids is a benchmark parameter under the proposed permit, and will be closely monitored with regard to vegetation management.

To avoid or alleviate effects on stormwater quality, short term projects which have a more temporary effect on the landfill surface will typically be scheduled during the drier months of the year, followed by seeding to re-establish vegetation.

Review of Stormwater Discharge Permit Conditions

Following is a summary of the conditions of the SJLF Stormwater Discharge Permit which influence the objectives of this plan, and are reflected in the stormwater monitoring strategy described under "Monitoring Strategies":

Existing Stormwater Discharge Permit for SJLF (1200-G Type Permit for Landfills). In November, 1990, the Environmental Protection Agency (EPA) adopted regulations requiring NPDES permits for discharges of stormwater to surface waters from specific industrial and construction activities (40 CFR 122-124). In Oregon, DEQ issues and enforces these permits. In 1991, DEQ issued a 1200-G type permit covering landfills to Metro for discharge of stormwater from SJLF. A requirement of this permit was the preparation and implementation of a Stormwater Pollution Control Plan (SWPCP).

In 1992, Metro commissioned Emcon to prepare the Stormwater Pollution Control Plan (SWPCP) for SJLF. The SWPCP includes monitoring locations and parameters, and infers any additional monitoring required to implement the "Stormwater Best Management Practices," (BMP) of the SWPCP. The BMP which are most relevant to SJLF include: "Waste Chemicals and Material Disposal" [to eliminate or minimize exposure of pollutants to stormwater], and "Erosion and Sediment Control."

Key conditions of the existing permit related to monitoring include:

- Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.
- All monitoring data must be tabulated and submitted to DEQ by July 1 of each year.
- Specific stormwater discharge limits include: Oil & Grease = 10 mg/l ; pH = 6 to 9 ; Toxicity = no discharge of toxic contaminants in toxic concentrations, defined as "lethality to aquatic life as measured by a significant difference in lethal concentration between the control and 100% effluent in an acute bioassay."
- No violations are allowed of applicable water quality standards as adopted in OAR 340-41 (except within a mixing zone in the receiving waters which would provide a 10:1 dilution of the discharged stormwater).
- The Storm Water Pollution Control Plan must include procedures for meeting any OAR for stormwater control specific to the Willamette River Basin. These procedures include a schedule of steps and key dates for implementing monitoring activities, and materials management practices.
- TMDL parameters must be monitored where receiving waters are water quality limited and TMDL standards have been established for those waters.
- When a landfill has been closed under a valid solid waste closure permit issued by the Department (all of the closure requirements have been met) the monitoring requirements under this permit shall be automatically terminated and this permit will not longer be required.

Prospective Stormwater Discharge Permit for SJLF (1200-Z Type General Permit). DEQ is in the process of streamlining the state's NPDES Stormwater Discharge Permit program by combining 11 types of permits (i.e. the 1200 series permits) into one, including the 1200-G type which was issued to Metro for SJLF. The combined permit will be called the 1200-Z type, and will recognize differences among the 11 permits where appropriate.

Among other changes from the existing permit, two are significant:

1. The limits specified by the existing permit will be replaced with benchmarks (for selected conventional parameters and 3 metals), which are guideline concentrations, not limitations.

They are designed to assist the permittee in determining if the implementation of the SWPCP is reducing pollutant concentrations to below levels of concern.

2. The permit specifically excludes requirements related to surface water quality regulations. It states that implementation of surface water standards for a specific watershed is the responsibility of the local agency (in the case of SJLF, the City of Portland). DEQ reserves the authority to create a new general permit for a specific watershed (e.g. the Columbia Slough), if OAR are adopted which require specific stormwater controls through the NPDES stormwater permits.

Following are the key requirements of the proposed permit, and key changes from the existing permit, which affect stormwater monitoring:

- The existing SWPCP must be revised not later than 90 days after receiving the new permit.
- The SWPCP shall be kept current and updated as necessary to reflect any changes in facility operation.
- By July 15 of each year, all monitoring data must be tabulated and submitted with written observations to DEQ for the previous monitoring period.
- The permittee is not required to conduct sampling if the benchmarks are met for at least four consecutive storm water monitoring events over 24 continuous months. There is no reduction in monitoring allowed for facilities subject to limitations under the Code of Federal Regulations.
- If benchmarks are not achieved, the permittee shall re-evaluate and update their SWPCP within 60 days of receiving sample results. Any additional practices or measures to improve the quality of stormwater discharges shall be implemented in a timely manner...
- If the permittee demonstrates that background or natural conditions cause an exceedence of benchmarks for certain parameters, then no further modifications to the SWPCP are required for those specific parameters. Upon successfully demonstrating this, the permittee would be eligible for the monitoring reduction as described above.
- DEQ may modify an existing general permit provided the public hearing process is followed, and may also develop a new general permit for a specific watershed if so desired to address additional requirements.

There are provisions under both the proposed and existing permits regarding reduction or termination of monitoring, under specified conditions. Under the existing permit, when all landfill closure requirements have been met, monitoring may be terminated and the permit itself may no longer be required. That provision is excluded from the proposed permit, and apparently has been replaced with a condition that if benchmarks are met for at least four consecutive stormwater monitoring events (2 years), sampling may be terminated. However, required monthly visual monitoring is not mentioned in this condition.

Reduction or termination of monitoring under the proposed permit would not result in reduction or termination of stormwater monitoring at SJLF required under the TMDL process, or other monitoring requirements specified by DEQ under OAR for surface water quality.

Monitoring Strategies

Overview

This section presents summaries of three stormwater monitoring strategies. Each strategy represents different monitoring objectives. Details related to these strategies are provided in Tables A, B and C, including monitoring parameters, monitoring station inventory, and sampling schedule, respectively. The station inventory (Table B) provides a summarized listing of monitoring stations, including the importance of monitoring at the locations identified below.

The stations included in these monitoring strategies are considered to be the primary stormwater outfalls for SJLF. There are a number of minor outfalls (i.e. low stormwater volume) on the landfill (see attached site map), some of which are currently specified in the existing SWPCP for monthly visual monitoring under the current Stormwater Discharge Permit. While these minor outfalls may have monitoring utility in the future, they are not specifically described or mentioned in this plan.

Strategy 1: Evaluate Compliance with Stormwater Discharge Permit

Objective. Stormwater quality will be monitored to meet requirements of the proposed SJLF Stormwater Discharge Permit (1200-Z type). Implementation of this strategy as described is dependent on both the approval by EPA of DEQ's proposed permit, and the approval by DEQ of Metro's modification of the SWPCP under the permit.

Measurements. Grab samples will be collected and analyzed twice per year (Spring and Fall) for selected conventionals including biologicals, and selected metals, at 6 outfalls which are representative of the major drainage areas of SJLF, and which have monitoring significance relative to particular features of those areas, as described below. To the extent practical, the Fall sample will be collected during the "first flush" of SJLF by stormwater after a prolonged dry period (typically during October).

Locations. It is Metro's opinion that outfalls from the 6 monitoring stations described below will be representative of stormwater from SJLF. However, monthly visual observations for selected physical parameters will be made at the 8 primary outfalls on the site. [see "Table B: Sediment Monitoring Station Inventory"]

The existing SWPCP would be modified to add stormwater monitoring stations R-2 and R-21 for semiannual sampling.

Following are the outfalls which will be recommended for semiannual sampling in the updated SWPCP:

1. Station R-2 -- culvert; representative of storm water runoff from northwest corner of SJLF into North Slough, including an area (Sub-Area 1) where the landfill cover is the oldest on the site (1992-1993); serves as useful comparison to station R-5, where cover was installed most recently; this comparison could help evaluate the stabilization of the landfill surface, as reflected in stormwater quality.
2. Station R-5 -- sedimentation basin; representative of stormwater runoff from northeast corner of SJLF into North Slough, including an area (Sub-Areas 4 & 5) where cover was installed in 1993 and completed in 1996.
3. Station R-8 -- culvert; representative of stormwater runoff from northeast corner of SJLF into Smith Lake, including an area (Sub-Area 5) where cover was installed in 1993 and completed in 1996.
4. Station R-10 -- sedimentation basin; representative of stormwater runoff from southeast corner of SJLF into the Columbia Slough, including an area (Sub-Area 5) which was closed in 1995-1996; drainage area includes maintenance building and sideyard (which will be moved off site to "Parcel A" during 1997), motor blower flare facility, and condensate wet well.
5. Station R-17 -- culvert; representative of stormwater runoff from southwest corner of SJLF into the Columbia Slough, including an area (Sub-Area 3) which was closed in 1994; drainage includes area of active sheep grazing during spring and summer months.
6. Station R-21 -- an oversized sedimentation basin at the southeast corner of SJLF. drains an area (Sub-Areas 4 & 5) which was closed in 1995-1996; discharges to Smith Lake. Over time, this basin may develop into a wetland.

Data Evaluation. All stormwater quality data will be evaluated for compliance with the benchmarks specified in the proposed permit, as follows:

Parameter	Benchmark *	Required Monitoring **
Copper (total)	0.1 mg/l	grab sample (2x / yr)
Lead (total)	0.4 mg/l	grab sample (2x / yr)
Zinc (total)	0.5 mg/l	grab sample (2x / yr)
pH	5.5 - 9 S.U.	grab sample (2x / yr)
Total Suspended Solids	130 mg/l	grab sample (2x / yr)
Oil & Grease	10 mg/l	grab sample (2x / yr)
E. coli	406 counts/100 ml	grab sample (2x / yr)
Settleable Solids	.2 ml/l	grab sample (2x / yr)
Floating Solids	no visible discharge	visual (1x / mo)
Oil & Grease sheen	no visible sheen	visual (1x / mo)
Debris	none or minimal	visual (1x / mo)

* proposed 1200-Z General Permit: *Stormwater Discharge Benchmarks*
** proposed 1200-Z General Permit: *Schedule B: Monitoring and Reporting Requirements*

Where benchmarks are not achieved, additional monitoring may be conducted as necessary and feasible to determine whether the SWPCP should be modified to include any additional practices or measures that will further improve the quality of stormwater discharges. In accordance with the permit, this reevaluation of the SWPCP must be done with 60 days of exceeding a benchmark, and any additional practices or measures required to meet the benchmark must be implemented in a timely manner.

The only other parameter which may be applicable to SJLF under the permit is temperature, which is described as an additional requirement in the proposed permit. While not specified as a required monitoring parameter, it is inferred that monitoring could be required. The permit states that if DEQ determines that the temperature of receiving waters is being increased by the permittee's stormwater discharge, management practices additional to those required by the SWPCP may be required to reduce the temperature of the discharge.

Annually, monitoring data will be tabulated in a report format, and with written field observations will be submitted to DEQ by July 15.

Strategy 2: Evaluate Compliance with Surface Water Regulations

Objective. Objectives for this strategy will be based on future direction from DEQ (or, the City of Portland) regarding TMDL for the Columbia Slough, and potentially OAR for the Willamette River Basin which specify stormwater controls and related monitoring.

Note that monitoring of stormwater temperature per OAR 340-41-26, if required under the proposed permit, would be included in Strategy 1. However, because temperature is also a TMDL parameter for the Columbia Slough, additional monitoring of temperature may be required under Strategy 2.

Under the proposed 1200-Z Permit, DEQ reserves the right to develop a new general permit for a specific watershed to address additional monitoring requirements, including TMDL and OAR relevant to surface water quality generally. This could result in a SJLF permit for discharge of stormwater to the Columbia Slough, which would combine monitoring requirements of the former permit and monitoring which addresses surface water quality regulations such as TMDL. If that were the case, Strategy 2 would be incorporated into Strategy 1.

When Smith and Bybee Lakes are returned to the Columbia Slough system through removal of the dam at the east end of the North Slough arm (tentatively, Fall of 1998), TMDLs for the Columbia Slough would presumably be applicable to the lakes, and objectives of this Strategy would be updated accordingly. If this occurs, monitoring of outfalls to Smith Lake (R-8 and R-21) would be modified as necessary.

Measurements and Locations. Methods for this strategy depend primarily on direction from DEQ and the City of Portland regarding monitoring procedures and reporting related to compliance with TMDLs for the Columbia Slough. This could include selected conventional parameters and selected toxics, reporting units, monitoring locations and sampling frequency.

In contrast to monitoring under Strategy 1, data collection under this strategy may include analysis of composited samples of stormwater, and would likely include estimates of stormwater flow, in order to estimate parameter loading to receiving waters.

Only one outfall (R-1) was constructed to measure stormwater flow. This outfall is from a sedimentation basin which is representative of runoff from the west side of SJLF, including an area (Sub-Areas 1, 2 & 3) which was closed between 1992 and 1994. The construction of station R-1 includes a flow meter positioned in a manhole between a sub-basin and the point of discharge. This can be used to measure the rate of discharge of stormwater. Flow information from this outfall, along with information about the drainage area, could serve as a basis for estimating flow from other outfalls. If feasible, flow may be measured at other outfalls as well.

Strategy 3: Address Specific Questions through Short-Term Investigations

Objective. Short-term, investigative monitoring of parameters/outfalls of interest will be conducted to answer questions if there is reason to believe that specific activities or incidents on SJLF may affect stormwater quality. For example, monitoring could be warranted by vegetation management or recreational development projects which temporarily alter the surface of certain areas of the landfill, by ongoing activities such as managed sheep grazing, or incidents such as breaks in condensate or leachate collection lines.

Measurements and Locations. Monitoring methods, including sampling locations, parameters, and timing, are dependent on the nature of the activities or incidents involved, and associated objectives. Because monitoring of stormwater is rainfall dependent, timely monitoring of the effects of a particular activity or incident may not be feasible.

For incidents such as collection line breaks, monitoring will be conducted as soon as possible, at the outfall(s) which is most likely to indicate effects on stormwater of the incident, if any. For example, a break in the landfill gas condensate main could result in the introduction of condensate to stormwater underdrains. Investigative stormwater monitoring would be performed as soon as feasible at the nearest outfall which drains the area of concern. Metro would attempt to resolve this type of problem quickly, and, in any case, it is expected that the volume of condensate likely to be involved would be negligible relative to the volume of stormwater outfall.

Monitoring of sheep grazing is an example of short-term investigative monitoring. During periods of active sheep grazing, outfalls which drain the central part of the grazing area may be monitored more intensively for parameters indicative of sheep manure, including e.g., enterococci, fecal coliform, total phosphorus, total Kjeldahl nitrogen, and potassium. Where monitoring demonstrates a problem, management actions or stormwater controls would be exercised.

Section 5

Leachate Discharge Monitoring

Introduction

This plan includes monitoring of leachate discharged from the St. Johns Landfill (SJLF) to the City of Portland sanitary sewer system. The plan comprises the following:

- Objectives
- Regulations
- Factors Integral to Monitoring Design
- Monitoring Strategies
- Sampling and Analysis Plan (see Section 6)
- Table A: Monitoring Parameters
- Table B: Sampling Schedule
- Figure 1: Map of Leachate Wet Well and Sampling Location (see Appendix for Tables and Figures)

Objectives

The primary objective of this leachate discharge monitoring plan is to routinely evaluate the composition of a mixture of landfill leachate and landfill gas condensate that is discharged from a wet well in a specified area of SJLF, to the City of Portland sewer system. This monitoring is performed in accordance with Metro's Industrial Wastewater Discharge Permit #400.018 with the City's Bureau of Environmental Services (BES). The collected data is evaluated and reported to BES consistent with the permit. Herein, the term leachate refers to the permitted leachate/condensate mixture, unless specified otherwise.

A secondary objective of the plan is to use the collected data, where feasible, in evaluating groundwater quality for SJLF and vicinity (see Groundwater Monitoring Plan). The data is potentially useful in that it provides information about the sources of groundwater contamination -- solid waste leachate and landfill gas.

Two monitoring strategies have been designed to meet the leachate discharge monitoring objectives:

Strategy 1 (Evaluate Compliance with Wastewater Discharge Permit): Leachate discharge data will be collected and evaluated for compliance with a revised Industrial Wastewater Discharge Permit to be developed based on new local limits and other new criteria for discharge composition. New discharge criteria have been proposed by BES to the Oregon Department of Environmental Quality (DEQ). [see section: "Review of Wastewater Discharge Permit Conditions"] However, until the revised permit is issued, monitoring will continue to be performed in accordance with the existing wastewater discharge permit. Strategy 1 will be modified as required based on the revised permit which is eventually issued by the City of Portland.

Strategy 2 (Address Specific Questions through Short-Term Investigations): Specific questions will be addressed through short-term investigative monitoring of leachate or landfill gas condensate, separately or as a mixture. These questions may relate to the composition of the discharge for purposes of permit compliance, or otherwise to the evaluation of data collected through the Groundwater Quality Monitoring Plan.

Locations and parameters monitored under either of these strategies may change based on modification of plan objectives, or new goals developed for the monitoring program.

Regulations

The Industrial Wastewater Discharge Permit #400.018 currently represents the main applicable regulation of Metro's monitoring and management of leachate quality at SJLF, and is integral to the objectives described above.

The permit authorizes Metro to discharge industrial wastewater (leachate) including condensate from the gas collection system at SJLF to the City of Portland sewer system in compliance with:

- Chapter 17.34 of the City of Portland Code
- City of Portland Bureau of Environmental Services rules
- Any applicable provisions of federal or state laws or regulations
- All permit conditions, including discharge point(s), effluent limitations, and monitoring requirements.

Specific monitoring requirements of the permit include sampling frequency, locations and parameters; discharge limits for specified parameters, and reporting format and schedule.

Factors Integral to Monitoring Design

Following are lists and summaries of factors that are reflected to varying extent throughout the plan. They are integral, or potentially integral to the design of monitoring strategies (measurements and locations), and will be incorporated as required into data evaluation.

Processes Affecting Leachate Quality and Quantity

Leachate which is discharged to the sewer is collected in a wet well from Sub-Area 5 of SJLF. This area of the landfill is the "expansion" area, where waste was disposed from 1985 to 1991 when waste was no longer accepted. In the wet well the leachate is mixed with gas condensate which is pumped to the well from the landfill gas collection system. This mixture is then pumped across a portion of the landfill through a force main to the point of discharge to the City sewer system at Columbia Boulevard. In the force main (just east of Landfill bridge) is an in-line valve where the sampling described under Strategy 1 of this plan is performed.

This leachate / gas condensate collection system has recently been upgraded to include a new power station, larger pump, and an improved force main with greater cleanout capacity. Disturbance or breaks in this system could potentially impact quality or quantity of discharge, and monitoring procedures of this plan will take such potential incidents into consideration (see Monitoring Strategy 2).

Processes affecting leachate quality and quantity include, but are not limited to:

- Reduction in the volume of leachate in the landfill as a result of the elimination by the landfill cover system of stormwater penetration into the solid waste and the formation of contaminated wastewater (leachate)
- Reduction in solid waste through ongoing decomposition of solid waste
- Reduction in landfill gas, as a result of a decrease in solid waste through decomposition

Completion of the cover system virtually eliminated stormwater penetration into the solid waste, and the resulting formation of contaminated wastewater (leachate). Because of this, the volume of leachate collected in the wet well is expected to decrease with time. The effect that this may have on leachate composition is unknown. However, the monitoring strategies implemented through this plan will evaluate leachate composition as a function of discharge flow rates and volumes.

Ongoing decomposition of solid waste also affects leachate composition. Like the potential effects of reduced flow on composition, the effects of decomposition will not be known until monitoring results provide indications of such changes.

In the longer term, the expected reduction in gas generation and condensate formation will affect the proportions of leachate and condensate in the discharged mixture, thereby affecting its composition.

Wastewater Discharge Permit Conditions

Following is a summary of the conditions of the SJLF Industrial Wastewater Discharge Permit which influence the objectives of this plan, and are reflected in the leachate monitoring strategies described under "Monitoring Strategies":

Existing Industrial Wastewater Discharge Permit for SJLF (#400.018). The City has administered a federally approved industrial wastewater pretreatment program since 1982. The purpose of the pretreatment program is to prevent discharges of harmful substances from industrial sources which can adversely affect the operation of the City's wastewater treatment works, in compliance with the Clean Water Act. The primary mechanism for doing this has been the enforcement, through the permitting process, of local limits for pollutant concentrations.

Key conditions of Metro's current permit related to monitoring include:

- Samples and measurements should be representative of the effluent (discharge);
- The permittee is required to document proper installation, and maintenance of flow monitoring and sampling equipment;
- If results indicate noncompliance, the permittee must notify the City's Source Control Management Section within 24 hr. of becoming aware of the noncompliance -- and possibly repeat the sampling;
- Accelerated additional monitoring should be performed as necessary to determine the nature and impact of the noncomplying discharge;
- Discharge limits for daily maximum totals of the concentrations of individual total toxic organics (TTOs) (2.13 mg/l), chlorinated hydrocarbons (0.5 mg/l), and phenolic compounds (1.0 mg/l), respectively.
- Specific discharge limits for heavy metals of concern, and conventional parameters of concern, including pH, ammonia, oil and grease, and flash point, as follows:

Parameter	Limit (daily maximum)
Cadmium	0.7 mg/l
Chromium	3.8 mg/l
Copper	2.3 mg/l
Lead	0.7 mg/l
Mercury	0.014 mg/l
Nickel	3.0 mg/l
Zinc	4.0 mg/l
Ammonia	50 mg/l
Oil & Grease (non-polar)	100 mg/l
Flash Point	>140° F
pH	6.87 S.U.

Prospective Permit Including New Discharge Standards. Over the past year, the City has proposed new criteria for discharge pollutants and is awaiting DEQ approval before finalizing its regulations.

The proposed criteria are based on the following considerations:

- water quality of the receiving stream (Columbia River)
- treatment plant process inhibition
- biosolids management program
- collection system
- nuisance odors/air toxics emissions
- worker health and safety

New local limits were proposed for heavy metals and selected conventional parameters of concern. It was proposed that no limits be applied to sulfate and ammonia. Instead, it was recommended that alternative control strategies (ACS) be applied to these pollutants where appropriate. ACS may include:

- enforcing prohibited discharge standards
- requiring pretreatment
- controlling batch discharges
- requiring spill prevention and containment

In the proposal, each organic pollutant of concern was assigned one of five discharge classifications, including:

1. Alternative Control Strategy -- existing local limit is replaced with an ACS to control discharge of pollutant of concern.
2. Conditional Discharge -- pollutant is amenable to biological treatment and does not have limiting environmental criteria.

3. Prohibited Discharge -- pollutant is not amenable to biological treatment or has a screening value or local limit less than 10 parts per billion.
4. Screening Value (mg/l) -- pollutant is amenable to treatment and has worker health and safety criteria.
5. Local Limit (mg/l) -- pollutant is amenable to biological treatment and has a limitation based on maximum allowable headworks loading (MAHL) or toxicity. The MAHL is the maximum allowable load that the City can manage at its headworks with respect to operational criteria.

Monitoring Strategies

Overview

This section presents summaries of two strategies for monitoring leachate discharge. Each strategy represents different monitoring objectives. Details related to these strategies are provided in Tables A and B, including monitoring parameters and sampling schedule, respectively.

Strategy 1: Evaluate Compliance with City of Portland Requirements

Objective. Leachate quality will be monitored as required by the City of Portland.

Location and Measurements. All samples will be collected at the in-line valve immediately east of Landfill bridge. Grab samples will be collected and analyzed once per month for required conventional parameters.

Flow-proportional composite samples will be collected and analyzed twice per year for TTOs, chlorinated hydrocarbons, and phenolic compounds, as required.

Data Evaluation. All leachate discharge data will be evaluated for compliance with City of Portland requirements. Results will be reported to BES according to the format and schedule specified by the City.

Laboratory results for leachate discharge samples collected periodically by BES at the same location will be evaluated as necessary.

Strategy 2: Address Specific Questions through Short-Term Investigations

Objective. Short-term, investigative monitoring will be conducted to address questions if there is reason to believe that specific activities or incidents at SJLF may affect the quality of leachate discharge. For example, monitoring could be warranted by incidents such as breaks in the gas condensate collection line, or the leachate discharge line.

Investigative monitoring may also be performed to provide supplemental information to the evaluation of groundwater quality data, if warranted.

Locations and Measurements. Samples may be collected at the in-line valve immediately east of Landfill bridge. Samples may also be collected at other locations in the leachate / condensate collection system, depending on objectives to be defined.

Monitoring methods, including sampling locations, parameters, and timing, are dependent on the nature of the activities or incidents involved, and associated objectives. Wherever possible, Metro will perform timely investigative monitoring of the effects of a particular activity or incident of concern.

Section 6

Sampling and Analysis Plan

Introduction

The Sampling and Analysis Plan is the field and laboratory procedures component of the Environmental Monitoring Plan for the Smith-Bybee Lakes Wildlife Area (SBWA) including St. Johns Landfill (SJLF). The objective of this plan is to optimize the accuracy and precision of environmental quality data collected from within SBWA through effective and controlled sampling, laboratory analysis, and field measurements. Monitoring procedures meeting these criteria will allow for accurate evaluations of environmental quality and associated environmental effects.

The term "sampling" herein means field measurements in addition to the collection of samples for laboratory analysis. "Laboratory" refers to any entity which has contracted with Metro to perform analytical laboratory services required by Metro's Environmental Monitoring Program.

In addition to complete and effective laboratory Quality Assurance / Quality Control (QA/QC), a key function of the plan in meeting the objectives is to employ procedures -- for detection, assessment and investigation --which provide field data and samples for laboratory analysis that are representative of environmental conditions (*e.g.*, hydrologic; hydrogeologic) at the time and location of sampling.

The principles and methods associated with the following sampling and analysis functions vary little among media sampled, and will be described in this plan overview; they include:

- Sample Storage, Labeling and Transport
- Field QA/QC
- Laboratory QA/QC
- Field measurement instrument calibration
- Equipment decontamination

Three other functions of the plan are largely dependent on the media sampled, and are described under the respective media sections of the plan; they include:

- Field Documentation
- Sampling Equipment
- Sampling Procedures

The sampling equipment and procedures described in this plan include those which are currently used, and also those which may be used in the future -- depending on the nature of changes in monitoring plan objectives. The Sampling and Analysis plan will be updated to describe in more detail equipment and procedures which are added because of monitoring objective modifications.

Metro personnel implementing the sampling function of the plan will adhere to the specifications described in this plan, unless unspecified measures are warranted based on unanticipated conditions. Where this occurs, any alternative measures employed will be fully explained and documented.

Where required when sampling, Metro personnel will wear personal protective clothing, use equipment and employ measures consistent with OSHA, EPA, and DEQ standard operating safety guidelines and procedures.

Sample Storage, Labeling and Transport

An essential function of the plan is the tracking of sample handling, from the time of container preparation and shipment from the laboratory to Metro, to the return of samples to the laboratory, including sample analysis.

Sample Labels

Containers will be requested by Metro as close in time to the sampling event as possible. After containers are received they will be stored in a dry and clean location.

The laboratory will prepare sample labels and secure them to the containers prior to shipment to Metro. Where applicable, the laboratory will identify on container labels preservatives in the containers, based on analytes requested by Metro (see below "Chain of Custody Record").

Upon sampling, Metro personnel will record the following information on each label:

- a unique sample identification
- location (*e.g.*, Columbia Slough; Smith Lake)
- date and time of collection
-

Sample Container Preparation

Metro will request containers from the laboratory, including the number of containers and analytes to tested. Based on this request the laboratory will provide the appropriate container types (composition, color, and volume), and will add preservatives as necessary, using the following as guidelines:

- Test Methods for Evaluating Solid Waste - Physical/Chemical Methods; SW-846.
- Methods for Chemical Analysis of Water and Wastes; EPA-600/4-79-020; 1983.
- Standard Methods for the Examination of Water and Wastewater; 18th edition.

Chain of Custody Record

A Chain of Custody sheet (COC) will accompany each sample collected by Metro. The COC will be provided by the laboratory. In preparing samples for transport, Metro will complete the COC with the following information:

- name and phone number of destination laboratory
- Metro/laboratory contract number
- name of sample collector(s)
- name of person recording the COC
- name of contact person
- site location and sample matrix type
- unique identification for each sample; associated date and time of collection
- parameters to be analyzed
- sample transport instructions if required
- notes regarding filtering of samples if required

Sample Analysis Request Sheet

A sample analysis request sheet prepared by the laboratory will accompany each sample through the analytical process, and will provide the following information:

- name of person receiving the sample
- date of sample receipt
- laboratory sample identification number
- analyses to be performed

Field Quality Assurance/Quality Control

Field QA/QC procedures ensure the reliability of field sampling and measurements, and contribute to the validity of the analytical results for collected samples. These procedures include transport blanks, which test the effects of contamination resulting from sample transport, if any; field duplicates, which test sampling precision; and field instrument calibrations which ensure accurate measurement of field parameters.

Transport Blanks

Transport blanks will be prepared and analyzed per sampling event if volatile or semi-volatile organic compounds are to be tested. These blanks will be prepared by the laboratory by filling containers with Type II reagent grade water. The containers will be transported to, and stored by Metro with the sample containers, and transported back to the laboratory with the collected samples. At no point in this process will these containers be opened or exposed. At the laboratory, these blanks will be analyzed for organic compounds using the same methods as for the collected samples.

Field Duplicates

Field duplicates will be two samples collected one immediately after the other at the same monitoring station, and will be analyzed for the same parameters. Field duplicate samples will be collected at a rate of one per ten sample locations. These duplicate samples will be given a unique identification number, transported, processed, and analyzed at the laboratory just like their companion (i.e., co-located) samples.

Field Instrument Calibration

Calibration of test sensors for field parameters will be performed once on each day of sample collection, according to procedures recommended by the field instrument vendor(s). Where required during sampling, maintenance and any associated re-calibration will also be performed.

Recordkeeping

Sampling Data Sheets will be used to record all relevant field observations and data (see below sampling and analysis plans for each media). Copies of all Sampling Data Sheets will be sent by Metro field staff who have recorded the information to a designated staff person at Metro headquarters within one week after samples are collected. This information will be stored both at St. Johns Landfill and at Metro Headquarters.

Chain of Custody Records and Sample Analysis Request Sheets will be sent by the laboratory to the at Metro Headquarters along with analytical results per the reporting schedule specified by Metro's contract with the laboratory.

Laboratory Quality Assurance/Quality Control

In order to further substantiate and validate the quality of analytical data, all laboratory procedures will be detailed in a Laboratory QA/QC Plan, to be prepared by the laboratory -- as a condition of its contract with Metro -- based on procedures and standards of the EPA Contract Laboratory Program; American Society of Testing and Materials; and Association of Official Analytical Chemists.

The QA/QC Plan will include the following:

- methods for preparing all sample containers and trip blanks
- routine instrument calibration procedures to standard reference materials
- specified holding time limits prior to which samples will be analyzed, by analyte or analyte class
- analytical methods of QC samples including blanks, duplicates, organic compound surrogate spikes and matrix spikes
- methods for evaluating the maintenance of control limits for QC results
- description of laboratory logbook for maintaining records of all analyses
- analytical result qualification by type, with associated reporting codes

Analytical QC will be performed at a minimum frequency of 10% (i.e., one complement of relevant QC tests per nine field samples analyzed). QC results (*e.g.*, % recovery; relative % difference) will be provided to Metro along with field sample results. These results will be used by Metro and the laboratory as a measure of performance and as an indicator of potential sources of cross-contamination. Routine QC control charts will be maintained and made available to Metro upon request.

A laboratory logbook of all analyses performed for Metro will be maintained a minimum of three years to document the sample processing steps, including:

- sample preparation technique (*e.g.*, dilution; extraction)
- analytical instruments
- analytical methods
- experimental conditions

Reporting of analytical results will include the following:

- sampling site and media
- dates and times of sampling
- date of receipt of sample by laboratory
- date of sample analysis
- laboratory sample identification number
- analytical method(s)

- measured concentrations
- method detection limits (MDLs) or
- method reporting limits (MRLs) or
- practical quantitation limits (PQLs)
- analytical qualifier where applicable

Field Measurement Instrument Calibration

Parameters of interest which are chemically-unstable will be measured only in the field. These parameters include pH, temperature, dissolved oxygen, specific conductance, and oxidation/reduction potential . Some combination or all of these parameters will be measured in each media. Currently, equipment used for field measurement of these parameters is supplied to Metro by Hydrolab Corporation. This equipment (herein referred to as the "Hydrolab") contains sensors for single or continuous (i.e. high frequency) measurement of the parameters identified above. The Hydrolab and any other equipment used for field measurements will be calibrated as required, and all equipment will be maintained to allow for accurate and precise measurement of water quality parameters.

Hydrolab Calibration

All Hydrolab instruments used in the field will be calibrated as required according to the following procedure:

1. All Hydrolabs that are deployed for high frequency monitoring will be brought in for maintenance and calibration every two weeks;
2. Hydrolabs used for single measurements (e.g., surface water grab samples) will be maintained monthly and calibrated prior to each use;
3. Procedures in the Hydrolab manual for maintenance and calibration of each sensor currently in use will be followed;
4. Initial and final calibration readings for each sensor will be recorded in a log book, as follows;
5. All other required field information will be recorded in the log book;
6. Battery voltage will be checked every two weeks on all units being used for high frequency monitoring.

Parameter	Initial Reading	Final Reading	Calibration Std.
depth (m)			
conductivity (mS/cm)			
pH (lower bound)			
pH (upper bound)			
dissolved oxygen (mg/l)			
dissolved oxygen % saturation			

Records will be kept of any equipment calibration and maintenance performed between sampling events. This will include records of equipment function problems, calibration and maintenance procedures, and dates.

Sampling and Analysis -- Groundwater

Sampling and analysis equipment and procedures described here relate only to testing of groundwater from St. Johns Landfill and vicinity. They will be consistent with monitoring requirements specified in Metro's Solid Waste Disposal Site Closure Permit (#116) with DEQ.

Field Documentation

Documentation of all relevant field activities is essential to meeting plan objectives. A "Groundwater Sampling Data Sheet" (see Appendix under Sampling and Analysis) will be used to record critical field information related to measuring and sampling groundwater at each monitoring well. The information recorded will include:

- name of collector(s)
- site location
- date and time of purging, sampling
- basic conditions such as climatic, condition of the well
- measurements of well static water elevation
- purge rates, volumes, and related calculations
- well recharge rates
- field measurements of certain indicator parameters
- sample containerization and preservation details
- observations of unanticipated conditions which may directly cause (or result in procedures which cause) deviation from this plan, potential contamination, or otherwise potentially anomalous data.
- results of field measurements

Sampling Equipment

Equipment: The equipment used for sampling groundwater will be dedicated to each well, thereby removing the risk of cross-contamination of samples and wells. The design of this equipment will allow for low-flow rate purging and sampling, while also providing the option to purge wells at greater flow rates as necessary. The combined aspects of equipment dedication and low-flow purging and sampling are expected to minimize disturbance to the groundwater in and around the screened interval, and of the well itself, thereby facilitating the collection samples which are representative of the geologic interval.

In addition to sample collection equipment, other equipment will be used for field measurements of groundwater. The design of this equipment will allow for accurate and precise measurement of certain key indicator parameters, and of well static water elevation.

Field equipment which will be used includes, but may not be limited to the following:

- Bladder pump with a polyvinyl chloride housing and check valves; and a polytetra fluoroethylene bladder membrane/tube; dedicated to each monitoring well
- Fluoroethylene polymer-lined discharge tubing (1/2 inch diameter.) from pump, dedicated to each monitoring well
- Air compressor for expanding bladder in order to push sample through discharge tubing
- Regulator for controlling flow rates
- In-line disposable filters with 0.45 micron membranes to remove particulates
- Electronic sensor for static water elevation measurements, sensitive to $\pm$ 0.01 foot, and including a polyvinyl chloride tape and 6" stainless steel shaft at tape end which contains a water-sensing pin
- Multiparameter field monitoring instrument, equipped with sensors for measuring pH, temperature, specific conductance, dissolved oxygen, oxidation/reduction potential, and salinity (currently, "Hydrolab")
- Sampling containers, as provided by the laboratory based on analytes to be sampled (see Sample Containerization under Sample Collection)

Sampling Procedures (Water Quality Data)

Sampling Preparations: Installation of Dedicated Sampling Equipment. An in-well bladder pump and discharge tubing will be dedicated to each well. Dedication of this primary sampling equipment avoids contamination. Therefore, routine decontamination is generally not required. However, all dedicated equipment placed within the well casing will be cleaned prior to installation using double-distilled water. Filters will be in-line and disposable.

After cleaning, the bladder pump will be positioned in each well such that the intake -- for both purging and sampling -- is located approximately in the middle of the screened interval. Discharge tubing from the pump to the top of the well will be installed. The pump and tubing will not be moved after initial placement in the well, until the well is abandoned for purposes of monitoring, or the equipment requires maintenance or replacement.

Preliminary testing of pumping and flow rates will be performed prior to each event, as necessary, at wells which are representative of different depths / geologic intervals. This testing will be designed primarily to provide guidance for employing appropriate flow rates at each monitoring well on sampling days.

Measurement of Well Static Water Elevation. Water elevation measurements will be taken from an established and marked reference point on the well. The reference point will be:

- established by licensed surveyor to an established National Geodetic Vertical Datum;
- permanent and easily identified mark;
- located on the top of the well casing with the locking cap removed; and
- periodically re-surveyed.

Static water level elevation measurement will be from an established reference point on the well, using the procedure described above for establishing the reference point. An electronic sensor is lowered with a graduated tape into the well until a signal indicates that water has been contacted. The tape indicates the depth in feet, which is then recorded. Between samplings, the sensor is decontaminated with a non-phosphate laboratory grade detergent wash, and a distilled water rinse.

If a well being sampled makes bubbling noises, or shows evidence of foam, this will be recorded on the sampling data sheet.

During purging, water level measurements will be taken as required to document drawdown. These measurements allow the sampler to control pumping rates to minimize drawdown, thereby minimizing the introduction of stagnant casing water into the discharge tubing.

Well Purging. Wells will be purged at flow rates which approximate well recharge rates, to avoid mixing the overlying stagnant water with the water adjacent to the well screen. This will be indicated by the stabilization of key indicators of background water chemistry during purging, and by static water elevation measurements (i.e. static water elevation should remain unchanged). These rates are expected to range from 100-1000 milliliters per minute, depending on well recharge rate.

To measure key indicators, the discharge line will be connected to a flow-through cell which is in direct contact with parameter sensors of the field parameters measurement instrument, for measurements and recording.

Because pH and temperature typically stabilize quickly, dissolved oxygen and specific conductivity will be considered the key indicators for stabilization. These parameters will be considered stable when they stabilize within the following variation:

- dissolved oxygen: +/- 0.2 mg/l
- specific conductivity: +/- 10.0 uS/cm

Other field parameters will be monitored continuously and recorded on the sampling data sheet during this stabilization process, including pH and temperature, oxidation/reduction potential, and salinity.

In addition, water level measurements will be taken as required to document drawdown. As described above, these measurements will allow the sampler to control pumping rates to minimize drawdown, thereby minimizing the introduction of stagnant casing water into the discharge tubing.

Purge water will be collected, consolidated in 55-gallon drums, and stored on site until a sufficient quantity is collected for testing to determine disposal status. Upon testing, where any parameter exceeds the MCL for drinking water the purge water will be disposed in the leachate pump station wet well unless its disposal could cause a violation of the Industrial Wastewater Discharge Permit (see Leachate Discharge Monitoring Plan). If any parameter exceeds the standard defining it as a hazardous waste it will be disposed of at a permitted hazardous waste disposal facility. Where this is not the case, it will be disposed of on the ground at the site.

Sample Collection: Sampling will proceed only after three successive measurements (at specific intervals) of the key indicator parameters have stabilized, and at least one pump and tubing volume have been purged. The discharge tube will be disconnected from the flow-through cell for discharge directly into sample containers.

Samples will be collected at flow rates equal to or less than the purge rate so that static water level in each well remains unchanged. Care will be taken to minimize turbulence and mixing of air with samples. Lower rates may be warranted based on the analytes to be tested, for example, volatile organic compounds which are more stable at lower flow rates (e.g. 100 milliliters per minute).

Grab samples for dissolved metals or any other dissolved contaminants will be filtered, using a Nalgene 0.45 micron disposable cartridge filter attached to a peristaltic pump. New filter cartridges and pump tubing will be used for each sampling station.

Containers with samples for volatile organic compound analysis will be filled with zero headspace so that volatiles will not escape from the liquid. Containers of samples for heavy metal analysis will not be allowed to overflow.

Samples will be collected and containerized in the order of decreasing volatility of the parameters to be analyzed, as follows:

- volatile organic compounds
- total organic halogens
- total organic carbon
- semi-volatile organic compounds
- total recoverable metals
- dissolved metals
- phenols

- cyanide
- sulfate and chloride
- nitrate and ammonia

Upon collection, most samples will be immediately stored in cooling chests with ice or ice packs, as required. These chests will be certified to maintain a 4 degrees Centigrade temperature during transport of sample containers.

Sampling Procedures (Water Level Data)

Data Collection (Monitoring Wells): Continuous water level data will be collected electronically in six monitoring wells penetrating the top of the sand/gravel aquifer, including D-6C, G-4B, G-5B, G-6, G-8B and G-8C. Water levels will also be recorded manually, both as a check on the logged data, as well as a way to calibrate the piezometers (by determining when the aquifer essentially has a flat water surface).

Data Collection (Piezometers): Piezometer data at multiple depths in the silts, sands, and gravels will be collected either continuously or monthly. The data loggers were installed at the locations of greatest current interest (see below), with the anticipation of moving the loggers as required over time. Monthly data will be taken at all other piezometer locations.

At 9 locations around the perimeter of the landfill, multi-level vibrating strip pressure transducers were installed as a string, and then backfilled with bentonite between each sensor. Six of these have shallow monitoring wells drilled a few feet away, which allows comparison and approximate verification of the water level data.

The piezometer data will be read as frequency, and converted to pressure (psi) using a polynomial expression (and calibration factors unique to each sensor, as obtained from the transducer manufacturer). Because the sensors are unvented, they will be adjusted for the atmospheric barometric pressure (primarily obtained from the Oregon Climate Center, and with gaps filled in from an on-site barometer).

Sampling and Analysis -- Leachate Discharge (St. Johns Landfill)

Sampling and analysis equipment and procedures described here relate only to testing of leachate discharged from St. Johns Landfill into the City of Portland sanitary sewer. As such, they will be consistent with monitoring requirements specified in Metro's Industrial Wastewater Discharge Permit (#400.018) with the City of Portland's Bureau of Environmental Services. If any new permits issued to Metro by the City specify monitoring methods different than those described below, this plan will be updated accordingly.

Field Documentation

Documentation of all relevant field activities is essential to meeting plan objectives. A "Leachate Sampling Data Sheet" (see Appendix under Sampling and Analysis) will be used to record critical field information related to measuring and sampling leachate at each monitoring station. The information recorded will include:

- name of collector(s)
- site location
- date and time of sampling
- leachate color and condition
- sample type (e.g., grab; composite)
- sample containerization and preservation details
- observations of unanticipated conditions which may directly cause (or result in procedures which cause) deviation from this plan, potential contamination, or otherwise potentially anomalous data.
- results of field measurements (if required)

Sampling Equipment

Leachate sampling equipment will include equipment used for collecting samples for laboratory analysis.

Field equipment which will be used includes, but may not be limited to the following:

- leachate pump and discharge line from wet well to sanitary sewer
- sampling containers, as provided by the laboratory per analytes to be sampled
- ISCO sampler (for in-line, composite sampling at programmed time intervals)

Sampling Procedures

Grab samples will be collected at the specified monitoring location accordingly to the following procedure:

1. The sampler will wear gloves.
2. The in-line valve will be opened.
3. Upon opening the valve, samples will be collected immediately by holding sample containers directly under the outfall, and without making contact between the container and surroundings.

4. Upon collection, samples will immediately be stored in cooling chests with ice or ice packs, as required. These chests will be certified to maintain a 4 degrees Centigrade temperature during transport of sample containers.

Composite samples will be collected at the specified monitoring location accordingly to the following procedure:

1. The sampler will wear gloves.
2. The in-line ISCO sampler will be programmed for either time proportional or flow proportional sampling.
3. For time proportional sampling, a start and stop time is entered, desired volume for each sample and number of samples to take - follow instructions in the operating manual.
4. For flow proportional sampling the daily flow must be estimated and the sampler programmed according to this volume - follow instructions in the operating manual.
5. When the sampling sequence is complete the sample will be placed in the appropriate lab container for the specified analyses.
6. Upon collection, samples will immediately be stored in cooling chests with ice or ice packs, as required. These chests will be certified to maintain a 4 degrees Centigrade temperature during transport of sample containers.
7. Chain-of -Custody records will be completed and sent to the lab with the samples.
8. Excess sample will be returned to the leachate / condensate collection system.

Sampling and Analysis -- Sediment

Sampling and analysis equipment and procedures described here relate only to testing of surface water sediments within the Smith-Bybee Lakes Wildlife Area. To the extent feasible, they will be consistent with methods used in the City of Portland's Columbia Slough Sediment Project (Remedial Investigation / Feasibility Study Phase).

Field Documentation

Documentation of all relevant field activities is essential to meeting plan objectives. A "Sediment Sampling Data Sheet" (see Appendix under Sampling and Analysis) will be used to record critical field information related to measuring and sampling sediment at each monitoring station. The information recorded will include:

- name of collector(s)
- site location
- date and time of sampling
- weather conditions
- wind conditions

- surface water depth to bottom
- sample type (e.g., grab)
- sediment characteristics (e.g., color, presence of oily sheen, odor, presence of biological items such as wood, macrophytes)
- sample containerization and preservation details
- observations of unanticipated conditions which may directly cause (or result in procedures which cause) deviation from this plan, potential contamination, or otherwise potentially anomalous data.
- results of field measurements (if required)

Sampling Equipment

Sediment monitoring equipment include equipment used for collecting samples for laboratory analysis, and equipment used for field measurements of sediment. Where applicable, equipment used for field measurements will be calibrated, and all equipment will be maintained to allow for accurate and precise measurement of sediment quality parameters.

The equipment used is dependent on the type of sample collected. Currently, the sediment monitoring plan specifies grab sampling only. These samples provide the nature and extent of contamination in the upper sediments which are the most biologically active layer (typically the upper 2 centimeters, or 0.78 in.).

Where it is decided that the vertical extent of sediment contamination must be measured to meet plan objectives, core samples will be collected. Where measurement of the bioavailability of sediments is required, a third type of sample -- sediment interstitial water (or, pore water) -- will be collected. The equipment required to collect all three types of sediment samples is described below.

Grab Sampling Equipment: Grab samples will be collected using a stainless steel Ponar dredge. This dredge is designed to collect sediments at shallow depth (e.g., the upper 2 cm.), without disturbing or contaminated the sample. The sampler will possess the following characteristics:

- create a minimal bow wave when descending;
- prevent twisting of the cable by using an attached hydrowire with a ball-bearing swivel;
- form a leakproof seal when the sediment sample is collected;
- prevent winnowing (scattering) and excessive sample disturbance when ascending;
- allow easy access to the sample surface.

Core Sampling Equipment: Where the monitoring plan is modified to include sediment core sampling, samples will be collected using a stainless steel manual corer with a 2 inch inner diameter, and with threaded extensions to accommodate different water and sediment depths.

The corer will be fitted with decontaminated polycarbonate liners that will contain the sediment samples before they are composited.

Interstitial Water Sampling Equipment: Where the monitoring plan is modified to include interstitial water sampling, samples will be collected using a pressurized squeezer that forces pore water from a large bore sediment corer. The squeezer is adapted with piston assemblies, pre-fit to the core tube to protect against leakage.

Other Sampling Equipment: Other equipment which will be used for sediment sampling includes:

- sampling containers, as provided by the laboratory per analytes to be sampled
- graduated metal tape (for measuring surface water depth to bottom at the point of sediment sampling)
- equipment for measuring field parameters, if required

Sampling Procedures

Following is the sampling procedure for collecting sediment grab samples using an Ponar Dredge. Note that procedures for collecting sediment cores and interstitial water will be added to the plan when required, as the methods for these sample types vary depending on objectives to be defined.

1. The Ponar Dredge will be lowered from a boat into the water at approximately one foot per second.
2. The weight of the dredge will be allowed to force it into the sediment, at which point the sample device is triggered and the jaws closed to form a tight seal.
3. After the sample is collected, the dredge is retrieved at a slow yet continual rate and placed on the boat deck, where it is inspected for quality.
4. The following grab sampling criteria from the Puget Sound Estuary Program will be used (Tetra Tech, 1986. *PSEP: Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound.* Prepared for USEPA Region 10):
   - sample is not over-filled (to prevent overflow of sediment from the dredge)
   - overlying water should be present in the dredge (indicates minimal leakage)
   - care is taken to prevent sample disturbance (indicated by nonturbid overlying water in the dredge)
   - sample surface is relatively flat (indicates minimal disturbance or winnowing)
   - desired sample depth is achieved

With the exception of samples collected for sediment grain size analysis, collected samples will immediately be stored in cooling chests with ice or ice packs, as required. These chests will be certified to maintain a 4 degrees Centigrade temperature during transport of sample containers.

Sampling and Analysis -- Stormwater (St. Johns Landfill)

Sampling and analysis equipment and procedures described here relate only to testing of stormwater outfall from St. Johns Landfill into surrounding surface waters. As such, they will be consistent with monitoring requirements specified in Metro's NPDES Stormwater Discharge General Permit (1200-G type permit for landfills) with DEQ. If any new permits issued to Metro by DEQ specify monitoring methods different than those described below, this plan will be updated accordingly.

Field Documentation

Documentation of all relevant field activities is essential to meeting plan objectives. A "Stormwater Sampling Data Sheet" (see Appendix under Sampling and Analysis) will be used to record critical field information related to measuring and sampling stormwater at each monitoring station. The information recorded will include:

- name of collector(s)
- site location
- date and time of sampling
- general weather conditions
- rainfall conditions (e.g., intensity, duration)
- air temperature
- water color and condition
- sample type (e.g., grab; composite)
- sample containerization and preservation details
- observations of unanticipated conditions which may directly cause (or result in procedures which cause) deviation from this plan, potential contamination, or otherwise potentially anomalous data.
- results of field measurements

Sampling Equipment

Stormwater sampling equipment include equipment used for collecting samples for laboratory analysis, and equipment used for field measurements of sediment. Where applicable, equipment used for field measurements will be calibrated, and all equipment will be maintained to allow for accurate and precise measurement of sediment quality parameters.

The equipment used is dependent on the type of sample collected. Currently, the stormwater monitoring plan specifies grab sampling only, per Metro's NPDES Stormwater Discharge

Permit. These samples provide the nature of contamination in the "first flush" of stormwater from SJLF, as described below under "Sampling Procedures".

Where it is decided that time-weighted or flow-weighted composite sampling is required to measure the nature and extent of stormwater sampling as a function of time or flow, composite samples will be collected.

Equipment used for stormwater grab samples includes:

- sampling containers, as provided by the laboratory per analytes to be sampled
- multiparameter field monitoring instrument, equipped with sensors for measuring pH, temperature, specific conductance, dissolved oxygen, oxidation/reduction potential, and salinity (currently, "Hydrolab")

Where composite sampling is required, based on objectives to be defined, the following equipment will be used, in addition to the equipment described above:

- automatic proportional sampling device connected to a flow measurement device and programmed (either variable time interval or variable volume) such that the volume of one composite sample is proportional to stormwater flow during the sampling period.
- Rain gages (for rainfall measurement)

Sampling Procedures

Following is the sampling procedure for collecting stormwater grab samples. General procedures for composite sampling and flow measurement are also described, although methods for these measurements vary depending on objectives to be defined.

Grab sampling: Grab samples will be collected at each monitored outfall identified in the Stormwater Pollution Control Plan for SJLF (per the Stormwater Discharge Permit) to characterize contaminant concentrations in samples collected once during the Spring and once during the Fall.

To the extent feasible, samples will be collected during the "first flush" of stormwater from the outfalls, defined here as the initial (30-minute) period of measurable surface water runoff after rainfall begins. First flush grab samples will characterize probable maximum contaminant concentrations during the storm.

Samples collected for the analysis of dissolved metals or any other dissolved contaminants will be filtered, using a Nalgene 0.45 micron disposable cartridge filter attached to a peristaltic pump. New filter cartridges and pump tubing will be used for each sampling station.

1. The sampler will wear gloves.
2. Samples will be collected by holding sample containers directly under the outfall, and without making contact between the container and surroundings.
3. Upon collection, samples will immediately be stored in cooling chests with ice or ice packs, as required. These chests will be certified to maintain a 4 degrees Centigrade temperature during transport of sample containers.

Chemically unstable parameters will be measured only in the field, using Hydrolab. These parameters include: pH, temperature, specific conductance, dissolved oxygen, and redox.

Flow-Proportional Composite Sampling: The monitoring plan does not include composite sampling of stormwater. However, where the evaluation of stormwater data from grab samples indicates a need for a more detailed analysis of stormwater, or where regulatory measures otherwise require it, composite sampling will be implemented.

Where this is the case, flow-weighted composite samples may be collected to characterize contaminant concentrations in storm water during a storm, as this sampling method is considered to be more representative of the average runoff quality than other methods such as time-weighted composite. In this case, a composite sample consists of a set of flow weighted subsamples or aliquots that are combined or composited into one sample. For example, composite aliquots could be collected at the onset of the storm and every 20 minutes for the first 3 hours of rainfall for a maximum of 9 subsamples.

Where necessary, rainfall will be recorded during each sampling interval to provide additional information for sample compositing, if needed.

Flow Measurement: When feasible and necessary, storm water flow will be measured to determine flow volumes for flow-weighted compositing. Storm water flow will be measured at regular intervals, associated with flow-weighted composite sampling, for the duration of the sampling event. At locations where storm water discharge cannot be estimated, relative flow depth and rainfall will be measured to determine a relative change in flow during the storm. The percent change will be used to estimate the percent storm water contribution for compositing.

Flow-weighted composite sampling will follow procedures described in the:
Guidance Manual for the Preparation of NPDES Permit Applications for Storm Water Discharges Associated with Industrial Activity (USEPA, 1991).

Flow measurement is used to calculate flow volumes during the storm. The relative proportion of flow volume during each interval will correspond to the relative proportion of the final composite sample contributed by any particular aliquot. For example, if 10% of the storm flow occurs during the first sampling interval, then 10% (e.g. 300 ml) of the final composite sample (3 L) will be composed of the first aliquot collected.

Following is the sample compositing procedure which will be used:

1. The appropriate portion of each aliquot sample volume (based on flow measurement) will be measured in a graduate cylinder (e.g. the 300 ml from the first interval), then poured into a large compositing container (e.g. decontaminated 5-gallon glass carboy), and mixed with the other aliquot proportions.
2. The composited sample is then used to fill all the laboratory containers required for chemical analyses.
3. Samples for dissolved metals are filtered using .45 micron membrane Nalgene filter.

Sampling and Analysis -- Surface Water

Sampling and analysis equipment and procedures described here relate only to testing of surface waters within the Smith-Bybee Lakes Wildlife Area.

Field Documentation

Documentation of all relevant field activities is essential to meeting plan objectives. A "Surface Water Sampling Data Sheet" (see Appendix under Sampling and Analysis) will be used to record critical field information related to measuring and sampling surface water at each monitoring station. The information recorded will include:

- name of collector(s)
- site location
- date and time of sampling
- air temperature
- tidal conditions
- wind conditions
- water color and condition
- approximate depth to bottom
- sample type (e.g., grab)
- sample containerization and preservation details
- observations of unanticipated conditions which may directly cause (or result in procedures which cause) deviation from this plan, potential contamination, or otherwise potentially anomalous data.
- results of field measurements

Sampling Equipment

Surface water monitoring equipment will include equipment used for collecting samples for laboratory analysis, and equipment used for field measurements of surface water. Field measurements will be taken in conjunction with grab sampling, and in high frequency monitoring of conventional water quality parameters. Equipment used for field measurements will be calibrated, and all equipment will be maintained to allow for accurate and precise measurement of water quality parameters.

Field equipment which will be used includes, but may not be limited to the following:

- sampling containers, as provided by the laboratory per analytes to be sampled (see Sample Containerization under Sample Collection)
- Secchi Disk (for measuring water clarity)
- multiparameter field monitoring instrument, equipped with sensors for measuring pH, temperature, specific conductance, dissolved oxygen, oxidation/reduction potential, and salinity (currently, "Hydrolab")
- graduated metal tape (for measuring depth to bottom)

Sampling Procedures

Water Column Sampling: Grab samples will be collected from the water column at each specified monitoring location accordingly to the following procedure:

1. The sampler will wear gloves
2. An initial sample will be collected with a Pyrex beaker (prewashed in double-distilled water), approximately 6 inches below the water surface, then discarded.
3. Another sample will be collected with the beaker, which will be used to transfer water to sample containers (filling each container without overflow); the beaker will be washed with double-distilled water for collecting the next sample.
4. Samples will be collected in a manner which minimizes contamination by floating oil or debris, or water which has contacted the hands, the outside of the sample container, the boat, the motor, and its combustion products.
5. Samples will be collected in an upstream direction will usually minimize the risks.
6. Samples for dissolved metals will be filtered, using a Nalgene 0.45 micron disposable cartridge filter attached to a peristaltic pump. New filter cartridges and pump tubing will be used for each sampling station.
7. Upon collection, samples will immediately be stored in cooling chests with ice or ice packs, as required. These chests will be certified to maintain a 4 degrees Centigrade temperature during transport of sample containers.

Chemically unstable parameters will be measured only in the field using the Hydrolab. These parameters include: pH, temperature, specific conductance, dissolved oxygen, and redox.

Hydrolab data Download and Re-Program (High Frequency Monitoring): The following procedure will be used for downloaded Hydrolab data which has been collected at high frequency, and for re-deploying the unit.

1. All Hydrolabs that are deployed for long-term monitoring shall be downloaded every two weeks
2. Follow download procedure in Hydrolab manual (data can either be downloaded to the Surveyor 4 and then to a PC or directly to a PC
3. All data should be downloaded in a spreadsheet compatible format
4. All data should be transferred to an Excel spreadsheet formatted to the Metro EMIS database
5. After all data is removed from the Hydrolab the file should be deleted
6. Following the procedure in the Hydrolab manual ,re-program the Hydrolab to log for the next two week interval
7. Re-deploy the instrument after all maintenance and calibration has been performed.

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APPENDIX
(Tables & Figures)

GROUNDWATER

SURFACE WATER

SEDIMENT

STORM WATER

LEACHATE DISCHARGE

SAMPLING AND ANALYSIS

GROUNDWATER

Table A
Groundwater Monitoring Parameters

Parameters are measured in groundwater samples from St. Johns Landfill and vicinity. For a given sampling parameters are selected based on the monitoring component being implemented. Parameters other than those listed below may be measured as warranted by objectives to be defined.

Conventionals (field)	Leachate Indicators	Heavy Metals	VOC	SVOC	SVOC	Pesticides	Herbicides	PCBs
pH	Total Alkalinity	Silver	1,1,1-trichloroethane	1,2,4-trichlorobenzene	Di-n-butylphthalate	Alpha BHC	2,4-D	Aroclor 1016
Temperature	Total Hardness	Arsenic	1,1,2,2-tetrachloroethane	1,2-dichlorobenzene	Di-n-octyl phthalate	Lindane	2,4-DB	Aroclor 1221
Specific Conductivity	Conductivity	Barium	1,1,2-trichloroethane	1,3-dichlorobenzene	Dibenzo(a,h)anthracene	Heptachlor	2,4,5-T	Aroclor 1232
Dissolved Oxygen	Chemical Oxygen Demand	Beryllium	1,1,2-trichloroethylene	1,4-dichlorobenzene	Dibenzofuran	Aldrin	2,4,5-TP	Aroclor 1242
Redox	Total Suspended Solids	Cadmium	1,1-dichloroethane	2-chlorophenol	Diethylphthalate	Beta-BHC	Dalapon	Aroclor 1248
Salinity	Total Dissolved Solids	Chromium	1,1-dichloroethylene	2,4,5-trichlorophenol	Dimethylphthalate	Delta-BHC	Dicamba	Aroclor 1254
Water Elevation	Total Organic Carbon	Cobalt	1,2-dichloroethane	2,4,6-trichlorophenol	Fluoranthene	Heptachlor epoxide	Tricamba	Aroclor 1260
	Ammonia	Copper	1,2-dichloroethylene	2,4-dichlorophenol	Fluorene	Endosulfan I	Dichloroprop	
	Ca (dissolved)	Iron	1,2-dichloropropane	2,4-dimethylphenol	Hexachlorobenzene	Endosulfan II	Dinoseb	
	Cl (dissolved)	Mercury	2-butanone (MEK)	2,4-dinitrophenol	Hexachlorobutadiene	Endosulfan sulfate	MCPA	
	Fe (dissolved)	Nickel	2-hexanone	2,4-dinitrotoluene	Hexachloroethane	pp-DDE	MCPP	
	Mg (dissolved)	Lead	4-Bromofluorobenzene	2,6-dinitrotoluene	Hexachlorocyclopentadiene	pp-DDD		
	Mn (dissolved)	Antimony	4-methyl-2-pentanone (MIBK)	2-chloronaphthalene	Indeno(1,2,3-cd)pyrene	pp-DDT		
	K (dissolved)	Selenium	Acetone	2-methylnaphthalene	Isophorone	Endrin		
	Na (dissolved)	Thallium	Bromodichlormethane	2-methylphenol	N-nitrosodimethylamine	Endrin aldehyde		
	Silica (dissolved)	Vanadium	Benzene	2-nitroaniline	N-nitrosodiphenylamine	Methoxychlor		
	Sulfate (dissolved)	Zinc	Bromoform	2-nitrophenol	N-nitroso-di-n-propylamine	Toxaphene		
			Bromomethane	3,3-dichlorobenzidine	Naphthalene	Chlordane		
	NO3 (dissolved)		Chlorodibromomethane	3-nitroaniline	Nitrobenzene			
	P (dissolved)		Carbon disulfide	4,6-dinitro-2-methylphenol	Pentachlorophenol			
			Carbon tetrachloride	4-bromophenyl-phenylether	Phenanthrene			
			Chlorobenzene	4-chloro-3-methylphenol	Phenol			
			Chloroethane	4-chlorophenyl-phenylether	Pyrene			
			Chloroform	4-chloroaniline	bis-(2-ethylhexyl)phthalate			
			Chloromethane	4-methylphenol	bis-(2-chloroethyl)ether			
			Ethyl benzene	4-nitroaniline	bis-(2-chloroethoxy)methane			
			Methylene chloride	4-nitrophenol	bis-(2-chloroisopropyl)ether			
			Styrene	Acenaphthene				
			Tetrachloroethylene	Acenaphthylene				
			Toluene	Aniline				
			Trichlorofluoromethane	Anthracene				
			Vinyl acetate	Azobenzene				
			Vinyl chloride	Butylbenzylphthalate				
			Xylenes (total)	Benzo(a)anthracene				
			cis-1,3-dichloropropene	Benzo(a)pyrene				
			p-dichlorobenzene	Benzo(b)fluoranthene				
			trans-1,3-dichloropropene	Benzo(g,h,i)perylene				
				Benzo(k)fluoranthene				
				Benzidine				
				Benzoic acid				
				Benzyl alcohol				
				Chrysene				

Table B
Groundwater Monitoring Wells and Piezometers Currently Usable

Monitoring Wells

Station	Screen Top (ft. COP)	Screen Bottom (ft. COP)
Silt Layer		
D-1A	0.3	-9.7
D-1B	-29.3	-39.3
D-1C	-59.5	-79.5
D-2A	-3	-13
D-3A	0.3	-9.7
D-3B	-31.2	-41.2
D-4A	3.4	-6.6
D-4B	-26.8	-36.8
D-6A	1.4	-8.6
D-6B	-20.2	-30.2
F-1	-13.4	-14.9
G-1	-19	-29
G-2	-24	-34
G-3R	-17.5	-27.5
G-4A	9.1	0.1
G-5A	4.9	-4.1
G-8A	6.8	-2.2
K-1	17.3	2.3
K-2	15.6	0.6
K-3	12.3	2.3
K-4	12	2
K-6A	14.2	-0.8
K-6B	-28	-38
Gravel Layer		
D-6C	-58.3	-78.3
G-4B	-28.7	-37.7
G-5B	-32.4	-42.4
G-6	-157.7	-167.7
G-7 (sand)	-9.3	-19.3
G-8B	-35.7	-40.7
G-8C	-71.7	-76.7
Solid Waste *		
H-1	12.5	2.5
H-2	17.5	7.5
H-3	20	10
H-4	19	9
H-5	33	23
K-5 **	14.4	-0.6

Piezometers

Station	Sensor Elevation (ft. COP)
Silt Layer	
P-1A	2.56
P-1B	-35.3
P-2A	3.71
P-2B	-56.16
P-3A	3.02
P-3B	-10.41
P-4A	3.47
P-4B	-22.41
P-5A	-4.21
P-5B	-43.74
P-6A	1.64
P-6B	-19.35
P-7A	3.75
P-7B	-13.19
P-8A	0.12
P-9A	0.71
P-9B	-13.29
P-9C	-33.11
Sand Layer	
P-1C	-65.2
P-2C	-123.34
P-2D	-140.29
Gravel Layer	
P-1D	-104.99
P-1E	-124.94
P-3C	-40.4
P-4C	-47.43
P-5C	-67.73
P-6C	-58.85
P-7C	-28.1
P-7D	-50.07
P-8B	-11.88
P-8C	-32.36
P-9D	-63.58

* Sampled monthly for water (leachate) level only

** Installed for monitoring overbank silts (with other K-series wells); inadveretantly screened in solid waste because boring log shows waste at this elevation.

Table C
Groundwater Monitoring Well and Piezometer Summary

Well	Status	Construct Date	Coordinate Location	Approx Ref. Elev.[1] (ft MSL)	Approx Bottom Elev.[2] (ft MSL)	Total Depth (ft)	Screen Location Depth (ft)	Material at bottom of boring	Well Casing	
									Dia.	Mat'l
A-1	Abandn'd (11/92)	1971	E12.370, N1,510							
A-2			E11,885, N1,892							
A-3			E12,790, N1,910							
A-4	Lost		E12,790, N1,910							
B-1	Lost	1971								
B-2	Abandn'd (11/92)		E11,090, N1,840							
B-3	Abandn'd (10/91)									
B-4	Abandn'd (11/92)		E11,035, N2,639							
B-5			E13,347, N1,980							
B-6	Lost									
C-1	Abandn'd (11/92)	1971	E12,424, N1,238							
C-2			E11,115, N1,245							
C-3	Abandn'd (5/92)		E10,859, N3,445							
C-4	Lost									
C-5	Abandn'd (11/92)		E12,290, N3,550							
D-1a	IN USE	10/9/84	E9,301, N3,239	27.3	-12	39	28-38	Clay	3"[3]	PVC
D-1b			E9,298, N3,232	27.7	-41.5	69	58-68			
D-1c			E9,295, N3,225	27.5	-83	110	88-108	Silt		
D-2a		9/29/84	E10,224, N2,453	27	-15	42	31-41	Clay		
D-2b	Abandn'd (11/92)	10/5/84	E10,227, N2,445	27.7	-44.5	72	61-71	Silt		
D-3a	IN USE	10/3/84	E10,070, N1,308	38.3	-12.5	50	39-49	Clay		
D-3b			E10,068, N1,305	37.8	-42	80	70-80	Clay, silt		
D-4a		10/5/84	E11,588, N1,202	23.4	-7	30	21-31			
D-4b			E11,583, N1,202	23.2	-39	62	51-61			
D-5a	Abandn'd (11/92)	10/17/84	E13,226, N1,335	31.7	-10.5	42	31-41			
D-5b			E13,217, N1,330	32.0	-40.5	72	61-71			
D-6a	IN USE	10/24/84	E14,248, N3,062	30.4	-2	41	30-40	Clay		
D-6b			E14,250, N3,054	29.8	-22.5	61	51-61			
D-6c			E14,252, N3,046	30.7	-80.5	111	90-110	Sand, gravel		
D-7a	Abandn'd (11/92)	10/16/84	E12,712, N3,587	28.9	-31.5	61	47-57			
D-8a	Abandn'd (5/92)		E10,928, N3,328	33.8	-37	71	66-71			

Table C
Groundwater Monitoring Well and Piezometer Summary

E-1	Abandn'd (11/92)	1979	E12,300, N3,420							
E-2			E13,280, N3,740							
EPA-B	Abandn'd (11/91)	1985	E10,253, N2,840							
EPA-O	Abandn'd (11/92)		E12,440, N2,040							
EPA-P			E11,632, N2,553							
EPA-Q			E11,286 N1,591							
EPA-R			E10,928, N3,328							
Familian	IN USE	?	E10,392, N733							
Port		1988	E9,439, N1,358							
SEA-B4		1987	E9,409, E1,253							
F-1	IN USE	1979		16.7	-11.5	28	23-28	Sandy silt?	3"	PVC
G-1	IN USE	8/30/88	E12,367, N1,200	24.1	-34.5	58.5	43-53	Silty sand	2"	PVC
G-2		8/31/88	E11,018, N1,244	24.0	-36	60	48-58	Silt, sand		
G-3		9/1/88	E13,550, N3,829	29.7	-28.5	58	46-56	Silt		
G-3R	IN USE	7/3/96	E13,560, N3,829	28.0	-32.0	59	46-56	Silt		
G-4a		10/6/88	E11,238, N3,781	17.6	-2	19.5	8.5-17.5			
G-4b		9/11/88	E11,236, N3,779	17.3	-40	57	46-55	Sand, gravel	4"	
G-5a		10/6/88	E13,387, N4,050	13.9	-7	21	9-18	Silty sand	2"	
G-5b		9/21/88	E13,387, N4,055	13.6	-44.5	58	46-56	Sand, gravel	4"	
G-6		10/12/88	E9,232, N2,663	17.3	-168.5	186	175-185			
G-7		10/5/88	E10,713, N3,491	16.7	-25	41.5	26-36		2"	
G-8a		10/7/88	E14,562, N1,146	45.4	-6	51.5	38.5-47.5	Sand		
G-8b		10/22/88	E14,564, N1,140	45.4?	-40.5	86	81-86	Sand, gravel		
G-8c					-79	124	117-122			
H-1	IN USE	7/30/90	E10,232, N3,037	60.5	-8.5	69[4]	48-58	Sandy clayey silt	2"	stain-less steel
H-2		8/16/90	E11,409, N3,046	75	-9	80[4]	57.5-67.5			
H-3		8/21/90	E11,710, N1,619	69	-5	74	49-59			
H-4		8/24/90	E12,740, N2,950	71	-7.5	66.5	40-50			
H-5		8/13/90	E13,865, N3,031	87	-5	92[4]	54-64	Silty clay/ clayey silt to fine sandy clayey silt		

Table C
Groundwater Monitoring Well and Piezometer Summary

K-1	IN USE	12/7/92	E10,999, N1,216	24.1	-0.4	21.3	4-19	Clayey silt	2"	PVC
K-2		12/17/92	E10,183, N2,426	27.5	-1.4	28.9	12-27	Clayey fine sandy silt		
K-3		12/8/92	E10,674, N3,494[5]	18.9	.9	17.3	5-15	Clayey silt		
K-4		12/8/92	E14,262, N3,129[5]	21.7	-3.3	22.6	10-20	Sandy clayey silt		
K-5	(see notes below: "K-series wells")	12/3/92	E13,407, N1,855	32.2	-3.5	35.3	18-33	Clayey silt		
K-6a		12/1/92	E13,255, N1,310[5]	31.9	-3.4	33.3	16-31	Sandy clayey silt		
K-6b		12/10/92	E13,265, N1,311[5]	30.8	-41.2	-42.2	27-37	Silty sand		

Piezometer	Status	Date Constructed	Coordinate Location	Approx Ref. Elev.[1] (ft MSL)	Approx Bottom Elev.[2] (ft MSL)	Total Depth (ft)	Piezometer location depths (ft)	Material at piezometer location	Piezometer Casing	
									Dia.	Mat'l
P-1a P-1b P-1c P-1d P-1e	IN USE	10/13/92-10/19/93	E10,989, N1,216	22.4	-129.0	148.3	18.5 56.3 86.2 126.0 146.0	silt/sand silt/sand sand gravel gravel	2"	PVC
P-2a P-2b P-2c P-2d	IN USE	11/23/92-12/2/92	E10,184, N2,438	26.2	-145.0	167	21.0 80.9 148.1 165.0	clayey silt sandy silt sand sand	2"	PVC
P-3a P-3b P-3c	IN USE	11/17/92-11/18/92	E10,666, N3,497	17.5	-42.0	58.5	13.0 26.4 56.4	Sa/cl/silt Cl/silt sand Sa/gravel	2"	PVC
P-4a P-4b P-4c	IN USE	10/5/92-10/6/92	E14,258, N3,122	18.7	-50.8	68.2	14.0 49.9 64.9	Silt/sand Silt/sand Gravel/sa	2"	PVC
P-5a P-5b P-5c	IN USE	11/9/92-11/12/92	E13,411, N1,850	31.5	-69.4	100.5	34.5 74.0 98.0	Clayey silt Silt Gravel	2"	PVC
P-6a P-6b P-6c	IN USE	10/28/92-10/29/92	E13,263, N1,316	30.3[5]	-61.2	89.7	26.9 47.9 87.4	Si/cl, sand Silt/clay Gravel	2"	PVC
P-7a P-7b P-7c P-7d	IN USE	9/10/92-9/11/92	E11,417, N3,476	27.9	-53.4	80.7	23.2 40.1 55.0 77.0	Clayey silt Sand, silt Gravel Gravel	2"	PVC
P-8a P-8b P-8c	IN USE	9/29/92	E11,454, N4,085	15.2	-34.6	48.9	12.9 24.9 45.4	Silt Silt Sa/gravel	2"	PVC
P-9a P-9b P-9c P-9d	IN USE	9/23/92	E14,776, N3,419	13.3	-67.5	78.9	11.1 25.1 45.0 75.4	Clayey silt Silty sand Silty sand Gravel	2"	PVC

Table C
Groundwater Monitoring Well and Piezometer Summary

Table Footnotes

note: SE/E, 5/89 = St. Johns Landfill Water Quality Impact Investigation and Environmental Management Options, Sweet Edwards-Emcon, May 31, 1989.

[1] D-wells: Reference elevation from SE/E, 5/89, p.19. (from top of well casing)
G-wells: Reference elevation from drill logs (SE/E, 5/89, Appendix B). Not outrightly stated, but appears to be ground surface elevation. Survey in App. K is approximately the same elevation, but doesn't state the point of measurement, either.
H-wells: Reference elevation at ground surface at time of drilling (CCI, 10/90, drill logs)
K-wells: Reference elevation at top of casing (CCI, 1/93, drill logs)
P-wells: Reference elevation at ground surface

[2] D-wells, G-wells: Approximate bottom elevation from SE/E, 5/89, pp. 19-21, based on drill logs
H-wells: Approximate bottom elevation from drill logs (CCI, 10/90)
K-wells: Calculated from drill logs (CCI, 1/93)

[3] 2" inserts placed in all the D-wells (D-3b: SE/E, 1988; remaining wells: Jensen Drilling, 1992)

[4] H-1: Backfilled to depth 64'
H-2: Backfilled to depth 80'
H-5: Backfilled to depth 80'

[5] Coordinates are very approximate. P-3, K-3, P-6 and K-6a and b are all based on only one control point.

Supplemental Notes: Monitoring Well History

An comprehensive evaluation of monitoring wells at and near St. Johns Landfill was performed by Sweet Edwards-Emcon in 1989. This included a review of the initial construction methods, activities that had occurred in the vicinity of the wells, and field observations at the well head. As a result of this evaluation, a list of wells suitable for monitoring water levels and water quality was compiled. The list included all wells constructed at that time. In addition, the study recommended that 19 wells be abandoned.

Following is a brief review by well series:

<u>D-series wells</u>. These wells were installed in 1984 in response to a request from DEQ. In 1988, DEQ noted that the majority of the D-series wells had a problem with siltation due to the interaction between the well screen slot size (fabricated by handsaw) and packing material used. Successful rehabilitation of D-3B was accomplished in 1988 by placement of a 2-inch diameter PVC casing liner and screen within the existing 3-inch casing. In the fall of 1992, similar rehabilitation work was performed on the remaining D-series wells used for monitoring.

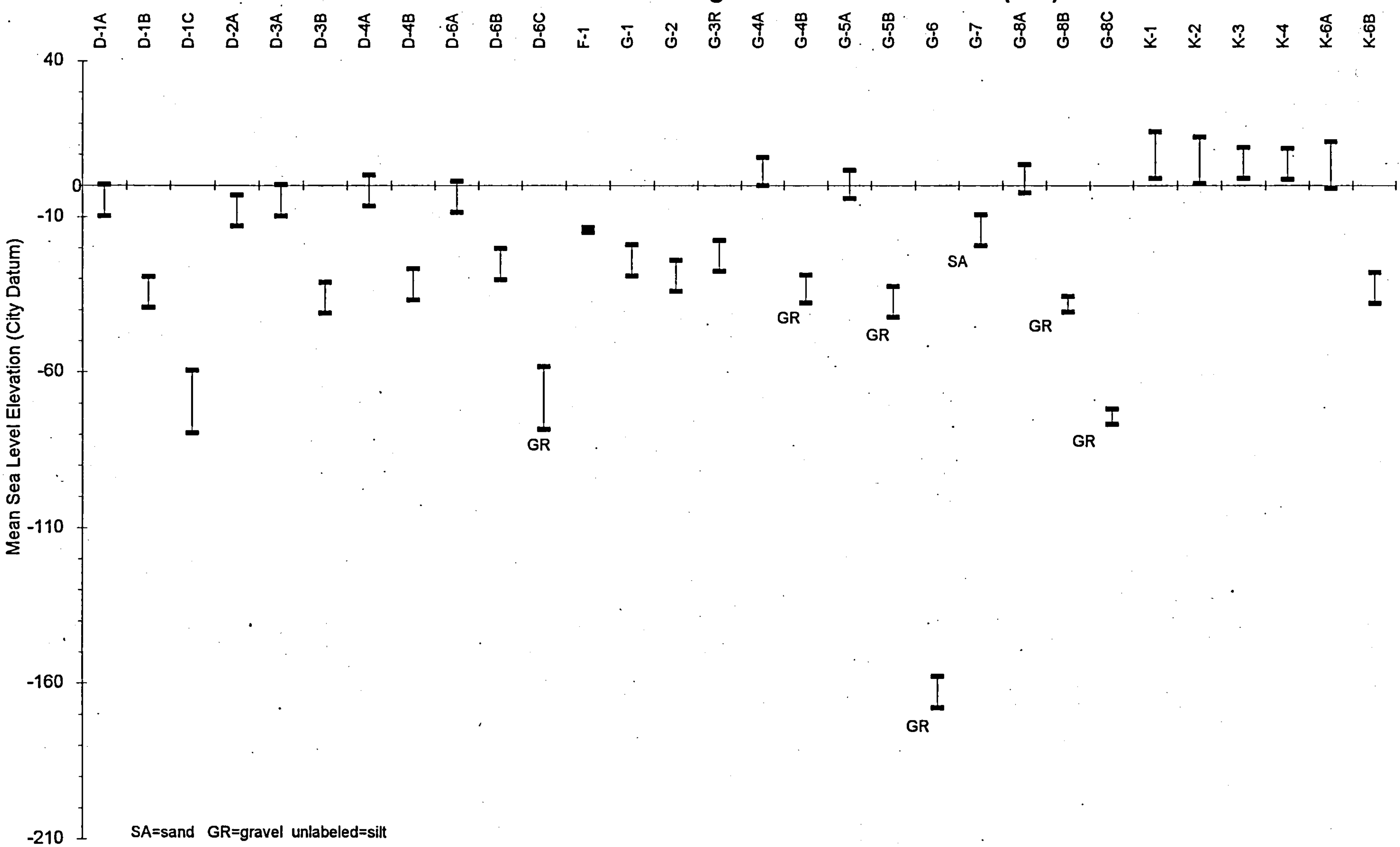
In the fall of 1992, wells D-5A and D-5B were considered damaged beyond repair, and were abandoned; D-2B was abandoned because there was a screen blockage which could not be removed; D-8a was abandoned due to a concern that its boring penetrated through the refuse into the Pleistocene gravels, potentially acting as a conduit for leachate migration. Two new wells were installed, K-6A and K-6B, to provide monitoring points in the vicinity of D-5A and D-5B.

<u>G-series wells</u>. These wells were installed during the late summer and fall of 1988. In the spring of 1996, G-3 was damaged as a result of landfill closure construction activity. In the summer of 1996, G-3 was abandoned and replaced with a new well (G-3R) which was installed 10 feet to the east, at approximately the same screen elevation.

<u>H-series wells</u>. These wells were installed in the summer of 1990. There are five wells in the series, one in each of the five subareas of the landfill which were delineated for closure purposes. All of the wells are screening in the refuse. In 1991, leachate from these wells was sampled and analyzed for a host of environmental contaminants. As a result of installing these wells, other wells screened in the refuse were considered unnecessary, and were abandoned; including A-2, B-5, EPA-B, EPA-Q, and EPA-R.

<u>K-series wells</u>. These wells were installed in the late summer and fall of 1992. With the exception of K-6B which replaced the abandoned monitoring well D-5B, the K-wells were shallow installations at the approximate depth of the slough. However, it is believed that K-5 was inadvertently screened in the refuse because its boring log shows refuse at this elevation. For this reason, K-5 is not included among regularly monitored wells. Data from the K-wells (with the probable exception of K-5) provides critical information regarding impacts on surrounding surface waters.

Figure 1
SJLF Groundwater Monitoring Well Screen Elevations (msl)



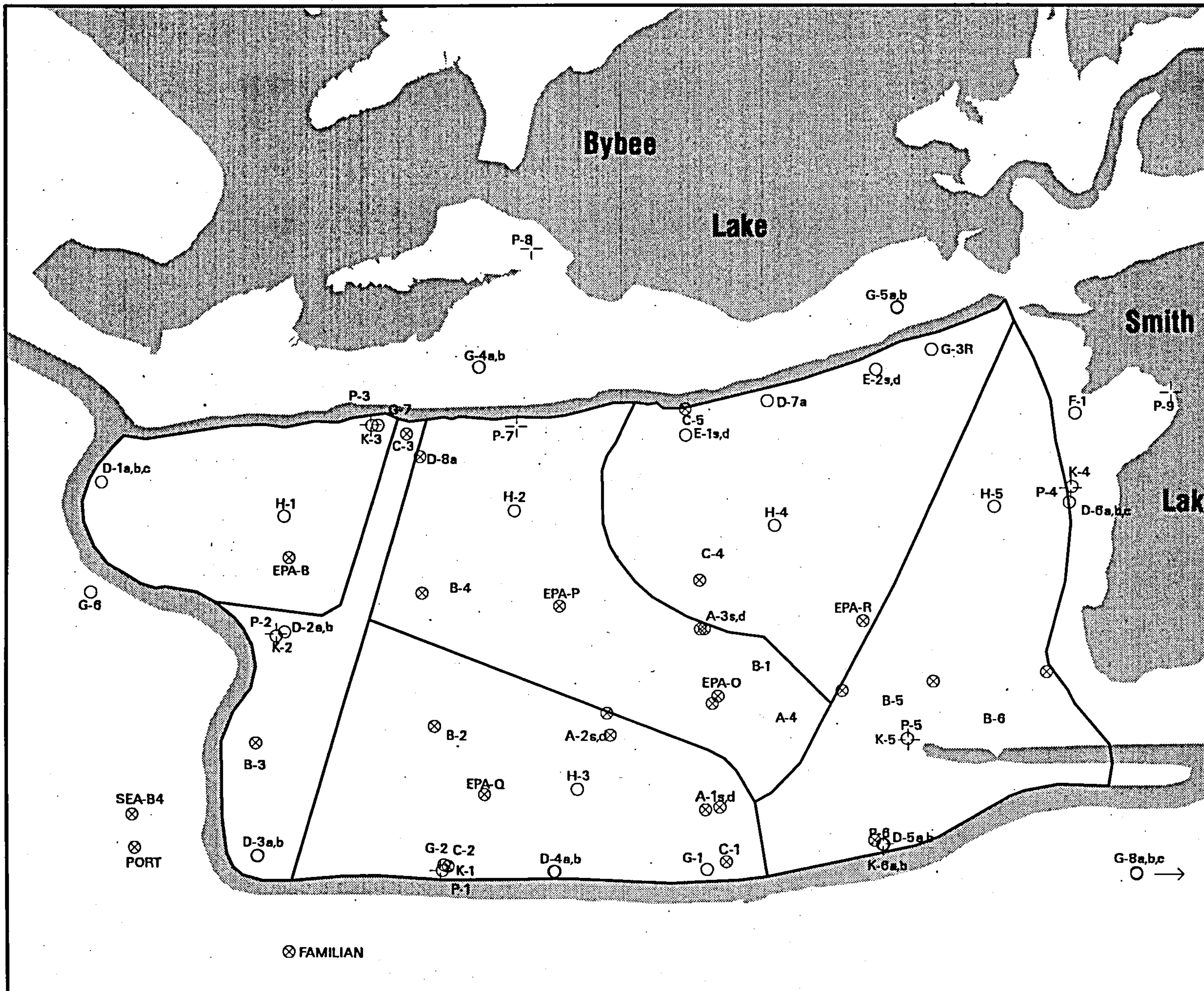
9/11/97

R L I S

REGIONAL LAND INFORMATION SYSTEM

Figure 2
St. Johns Landfill

Groundwater Monitoring Locations



Well Type

- Monitoring Well - Usable
- Monitoring Well - Not Usable
- Piezometer
- Subarea Boundaries

Scale: 1" = 750'

0 250 500 750 1000

METRO

600 NE Grand Ave.
Portland, OR 97232-2736
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Email drc@metro.dst.or.us

Please recycle with colored office grade paper

97071/gwater.aml, plot date: September 09, 1997

SURFACE WATER

Table A
Surface Water Monitoring Parameters

Parameters are measured in surface water samples from Smith-Bybee Lakes Wildlife Area. For a given sampling parameters are selected based on the monitoring component being implemented. Parameters other than those listed below may be measured as warranted by objectives to be defined.

Conventional (Hydrolab)	Conventional (Analytical)	Nutrients	Biological	Dissolved Heavy Metals
pH	Dissolved Chloride	Ammonia	Enterococci	Silver
Temp	Biochemical Oxygen Demand	Nitrate + Nitrite	Fecal Coliform	Arsenic
Conductivity	Chemical Oxygen Demand	Total Nitrogen (TKN)	Chlorophyll A	Barium
DO	Total Hardness	Total Phosphorus	Pheophytin	Beryllium
DO-%	Total Alkalinity	Ortho Phosphate (dissolved available P)	Algal Biovolume *	Cadmium
Redox	Total Organic Carbon			Chromium
	Total Solids			Cobalt
	Total Suspended Solids			Copper
	Total Dissolved Solids			Mercury
				Nickel
				Lead
				Antimony
				Selenium
				Thallium
				Vanadium
				Zinc

* will be analyzed only as required for investigative monitoring

Table B
Surface Water Monitoring Station Inventory
(see Figure 1)

Station	Description	Relevant Component *	Monitoring Significance: General	Monitoring Significance: High Tide	Monitoring Significance: Low Tide
J	N. Portland Rd. bridge	1, 2	eastern boundary of SBWA in Columbia Slough; indicative of "external" influence (from points east)	some influence of Willamette River	net effect of conditions and contaminants from point east in Columbia Slough, outside SBWA
K	Lombard Ave. bridge	1, 2	northwestern boundary of SBWA in Columbia Slough; indicative of "external" influence (Willamette and Columbia rivers)	dominant influence of Willamette River	net effect of surface waters conditions within SBWA
C	Landfill bridge	1 **	cental point along SJLF in Columbia Slough;	mixing of Willamette River and Columbia Slough waters	net effect of conditions and contaminants from points east in Columbia Slough, including outside SBWA
E	Junction: N. Slough arm and main channel of Columbia Slough	3	key location for assessing tidal effect	mixing of Willamette River and Columbia Slough waters	net effect of conditions and contaminants from Columbia Slough, North Slough arm, and lakes
H	East end North Slough	1, 2, 3	indicative of North Slough water quality generally	before dam removal, negligible tidal effect after dam removal, dominant influence of Willamette River	before dam removal, negligible tidal effect after dam removal, net effect of conditions and contaminants from tidal marsh
BL	Bybee Lake	2, 3	indicative of general water quality in Bybee Lake; central location at approximate deepest point	before dam removal, no tidal effect after dam removal, dominant influence of Willamette River	before dam removal, no tidal effect after dam removal, net effect of mixture of marsh and river conditions and contaminants
SL	Smith Lake	2, 3	indicative of general water quality in Smith Lake; central location at approximate deepest point	before dam removal, no tidal effect after dam removal, dominant influence of Willamette River	before dam removal, no tidal effect after dam removal, net effect of mixture of marsh and river conditions and contaminants
TP	Turtle Pond	2	water body which is confined most of the year useful comparison to tidally affected waters important to painted turtle habitat characterization	before dam removal, no tidal effect after dam removal, no tidal effect	before dam removal, no tidal effect after dam removal, no tidal effect
TS	Turtle Slough	2	water body which is confined most of the year useful comparison to tidally affected waters important to painted turtle habitat characterization	before dam removal, no tidal effect after dam removal, little or no tidal effect	before dam removal, no tidal effect after dam removal, little or no tidal effect

* 1 = high frequency monitoring (Hydrolab)
2 = low frequency monitoring (Hydrolab; other conventionals; biologicals; dissolved metals)
3 = monitoring for baseline or effects data in areas associated with environmental enhancement projects

** Monitored by City of Portland (BES); data will be used as necessary to meet plan objectives

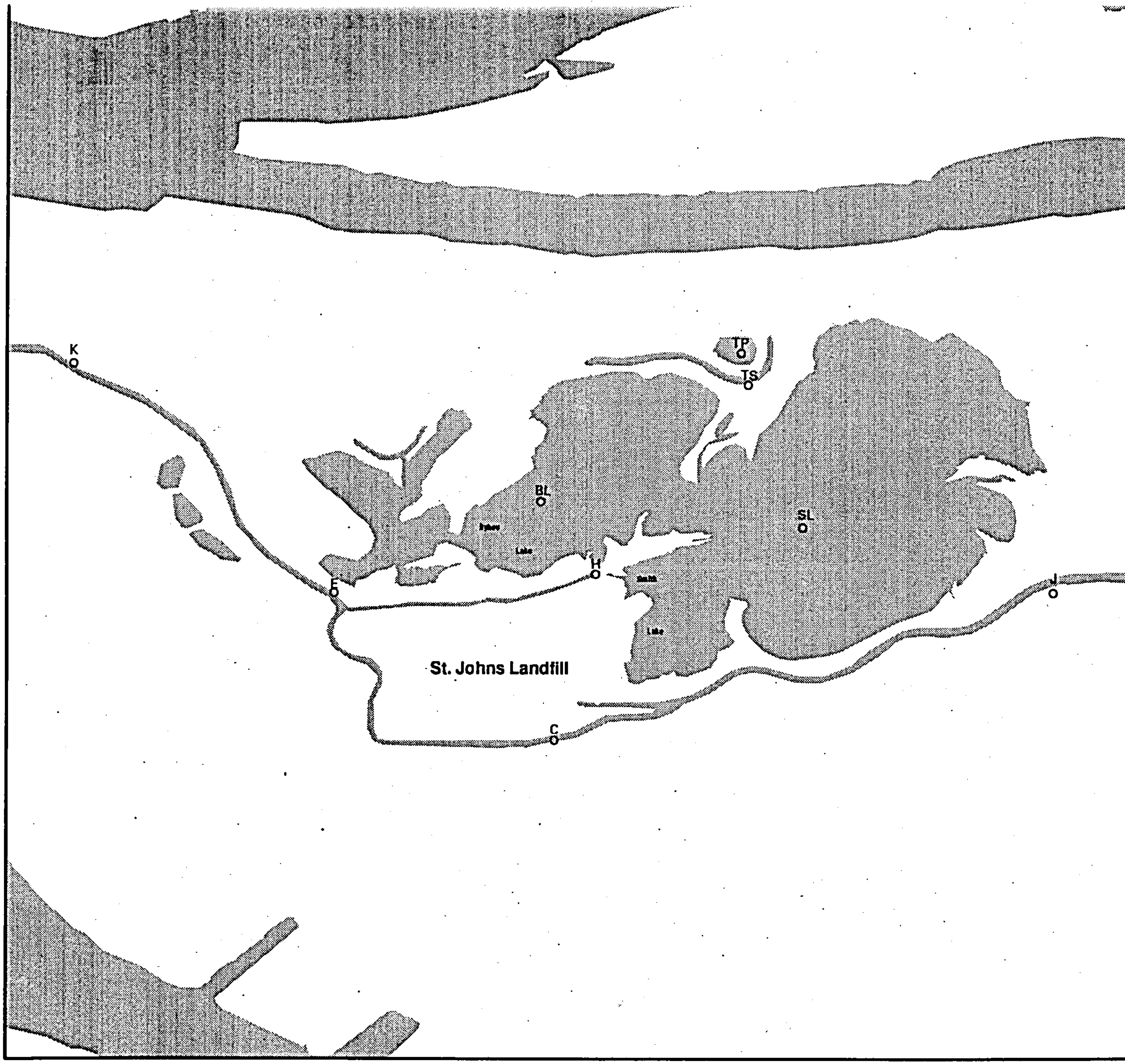
Table C
Surface Water Monitoring Schedule

Station ID	Station Description	Sampling Events per year	Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec
Component 1:	**High Frequency Monitoring**	**Conventional ("Hydrolab') Parameters**												
J	North Portland Road bridge	-	-	-	-	-	-	-	-	-	-	-	-	-
H	east end North Slough	-	-	-	-	-	-	-	-	-	-	-	-	-
K	Lombard Avenue bridge	-	-	-	-	-	-	-	-	-	-	-	-	-
		Dash (-) indicates year-around measurement of conventional parameters using hydrolab, at intervals required to meet plan objectives.												
Component 2:	**Low Frequency Monitoring (Grab Sampling)**	**a) Conventional ("Hydrolab') Parameters**					**b) Other Conventional Parameters, Biological Parameters, Metals**							
J	North Portland Road bridge	6	1				1		1	1	1	1		
H	east end North Slough	6	1				1		1	1	1	1		
BL	Bybee Lake, central location	6	1				1		1	1	1	1		
SL	Smith Lake, central location	6	1				1		1	1	1	1		
K	Lombard Avenue bridge *	6	1				1		1	1	1	1		
TP	Turtle Pond	3	1				1				1			
TS	Turtle Slough	3	1				1		1			1		
		Shading indicates time periods during which one sample is collected, based on current objectives.												
		* sampling conducted at high tide; all other Stations sampled at low tide												

Table D
Surface Water Data Evaluation Objectives
Component #1: High Frequency Monitoring

"Hydrolab" parameter	Guidance value or standard	Factors which influence parameter value	Critical time periods	Initial Data Evaluation Strategy
Temperature	7-day daily maximum not to exceed 68°F , note that sources in compliance with a management plan are deemed in compliance even if this temperature is not met*	Temperature of inflows, meteorological conditions, shading, depth of water	summer, low water conditions	determine numerical compliance with guidance value or standard
Dissolved Oxygen	Instantaneous > 4 mg/l; 7 day mean minimum of 5 mg/l; 30 day mean minimum of 6.5 mg/l**	heterotrophic bacteria (BOD), COD, ammonia, SOD, algae, zooplankton, O_2 gas transfer	winter during periods when deicing chemicals are used; summer during periods of high biological activity and low-water conditions	determine numerical compliance with guidance value or standard (note that in computing statistics for dissolved oxygen no credit is given for supersaturation)
pH	6.5-8.5 optimal range, outside this range may be an issue even though the DEQ acknowledges that the pH sometimes can be as low as 6 and as high as 9**	algae, heterotrophic bacteria (BOD), CO_2 gas exchange	summer during periods of high algae growth where pH excursions above the standard are possible	determine numerical compliance with guidance value or standard
Depth	none	tidal conditions, storm events		used in determining cause effect relationship if water quality violation
Conductivity	none	source of water		used in determining cause effect relationship if water quality violation

* *Proposed TMDL for Columbia Slough*
** *1992-1994 Water Quality Standards Review (this needs to be verified for the Columbia Slough - I applied the "cool water" criteria*



REGIONAL LAND INFORMATION SYSTEM

Figure 1: Smith Bybee Lakes

Surface Water
Monitoring Locations

N
E
W
S

Scale: 1" = 2400'

0 1200 2400

METRO

600 NE Grand Ave.
Portland, OR 97232-2736
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Email drc@metro.dst.or.us

SEDIMENT

Table A
Sediment Monitoring Parameters

Parameters are measured in sediment samples from Smith-Bybee Lakes Wildlife Area. For a given sampling parameters are selected based on the monitoring strategy being implemented. Parameters other than those listed below may be measured as warranted by objectives to be defined.

Conventionals	Total Metals	Pesticides	Herbicides	PCB	PAH	Bioindices
Total Organic Carbon (%)	Silver	Alpha BHC	2,4-D	Arochlor 1016	Naphthalene	Benthic Community
Total Solids (%)	Arsenic	Lindane	2,4,5-TP (Silvex)	Arochlor 1221	Acenaphthylene	Characterization
Acid Volatile Sulfides	Barium	Heptachlor	2,4,5-T	Arochlor 1232	Acenaphtylene/Fluorene	
Simultaneously Extracted Metals	Beryllium	Aldrin	Dalapon	Arochlor 1242	Phenanthrene	
	Cadmium	Beta-BHC	Dicamba	Arochlor 1248	Anthracene	
Grain Size	Chromium	Delta-BHC	Tricamba	Arochlor 1254	Fluoranthene	
	Cobalt	Heptachlor Epoxide	MCPA	Arochlor 1260	Pyrene	
	Copper	Endosulfan I	MCPP		Benzo(a) anthracene	
	Mercury	pp-DDE	Dichlorprop		Chrysene	
	Nickel	Dieldrin	2,4-DB		Benzo(b)fluoranthene	
	Lead	Endrin	Dinoseb		Benzo(k)fluoranthene	
	Antimony	pp-DDD			Benzo(a)pyrene	
	Selenium	Endosulfan II			Dibenzo(a,h)anthracene	
	Thallium	pp-DDT			Benzo(g,h,i)pyrylene	
	Vanadium	Endrin Aldehyde			Indeno(1,2,3-cd)pyrene	
	Zinc	Endosulfan Sulfate				
		Methoxychlor				
		Toxaphene				
		Chlordane				

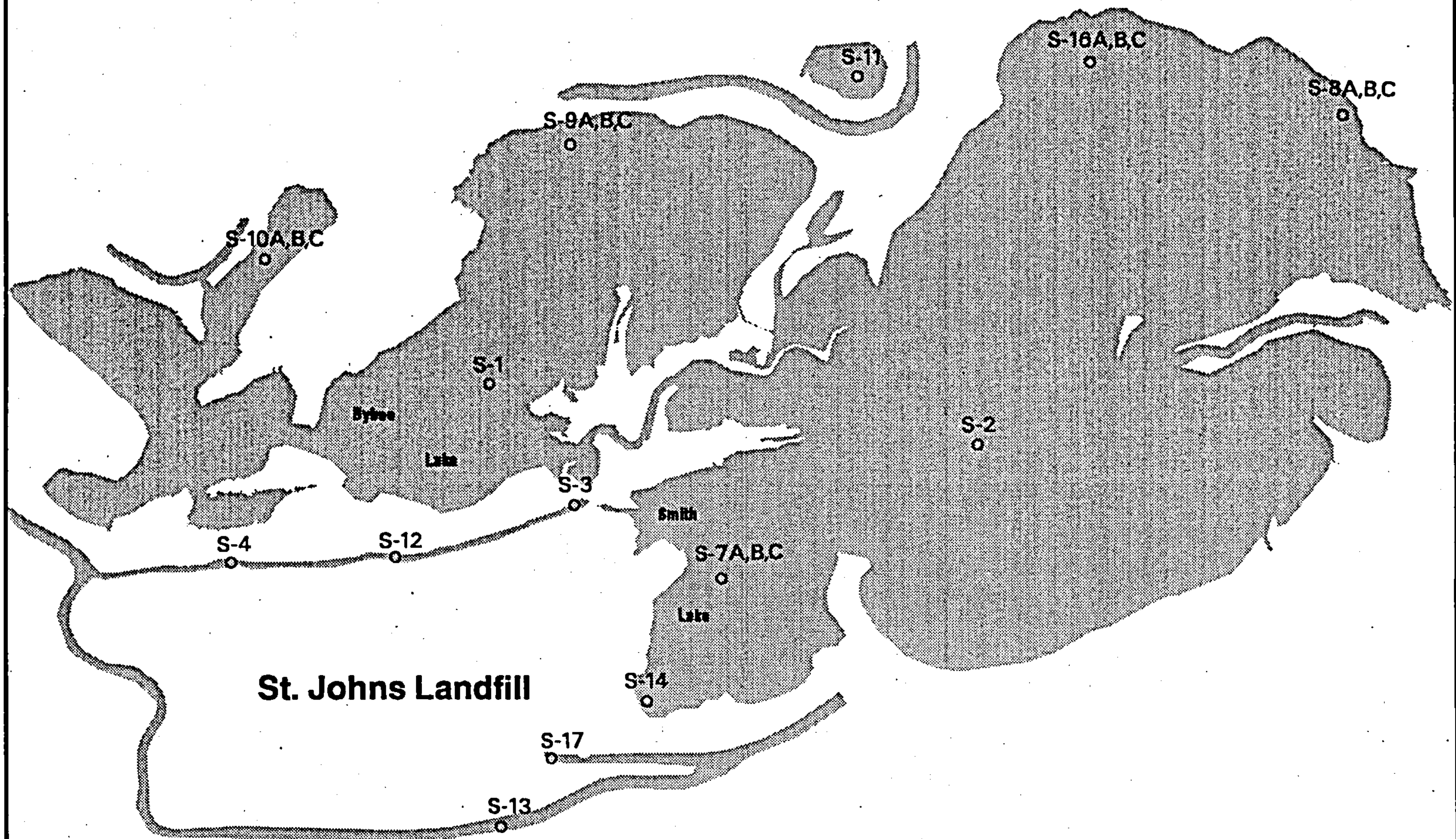
Table B
Sediment Monitoring Station Inventory
(see Figure 1)

Station	Description	Relevant Strategy *	Monitoring Significance
S-1	Bybee Lake, central	1	representative of Bybee Lake sediment quality (central location at approximate deepest point); after dam removal, may be indicative of net effect on sediments of mixture of tidal marsh and river water
S-2	Smith Lake, central	1	representative of Smith Lake sediment quality (central location at approximate deepest point); after dam removal, may be indicative of net effect on sediments of mixture of tidal marsh and river water
S-3	North Slough (east)	1	under SJLF stormwater outfall R-5; in critical hydrology management area, between existing dam and prospective location of new water control structure;
S-4	North Slough (west)	1	under SJLF stormwater outfall R-2
S-12	North Slough (central)	1	facilitates evaluation of overall sediment quality in the North Slough, being located approximately equidistant from North Slough east and west stations; may be indicative of impact of SJLF
S-13	Landfill bridge	1	area highlighted by BES Columbia Slough Sediment Project as relatively high risk site for sediment-dwelling organisms; near CSO #54
S-17	Blind Slough	1	terminus of this reach highlighted in previous studies for sediment contamination
S-8	Suttle Road. outfall (Smith Lake)	2	near outfall of stormwater from catchment area for North Suttle Road industries
S-9	Marine Drive (west) outfall (Bybee Lake)	2	near outfall of stormwater from catchment area for Marine Drive industries
S-10	Ledbetter Road outfall (Bybee Lake)	2	near outfall of stormwater from catchment area for Marine Drive industries
S-11	"Turtle Pond" off Marine Drive	2	generally isolated water body within SBWA, receives runoff from commercial area along Marine Drive
S-16	Marine Drive (overpass) outfall (Smith Lake)	2	near outfall of stormwater from catchment area is the Marine Drive overpass (i.e. over the railway)
S-7	Smith Lake; western corner near landfill	3	near SJLF stormwater outfall R-7; may have been impacted by past stormwater which was contaminated through contact with solid waste
S-14	Smith Lake: west corner near landfill	3	near SJLF stormwater outfall R-21

* 1 = annual monitoring of strategic locations
2 = annual monitoring of stormwater outfall
3 = annual monitoring of landfill stormwater outfall

Table C
Sediment Monitoring Schedule

Station ID	Station Description	Sampling Events per year	Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec
Strategy 1: Annual Monitoring at Strategic Stations														
S-1	Bybee Lake, central	1					1							
S-2	Smith Lake, central	1					1							
S-3	North Slough (east)	1					1							
S-4	North Slough (west)	1					1							
S-12	North Slough (central)	1					1							
S-13	Landfill bridge	1					1							
S-17	Blind Slough	1					1							
Strategy 2: Annual Monitoring Near Stormwater Outfalls														
S-8	Suttle Road. outfall (Smith Lake)	1					1*							
S-9	Marine Drive (west) outfall (Bybee Lake)	1					1*							
S-10	Ledbetter Road outfall (Bybee Lake)	1					1*							
S-11	"Turtle Pond" off Marine Drive	1					1							
S-16	Marine Drive (overpass) outfall (Smith Lake)	1					1*							
		* transect of 3 samples collected at the specified station												
Strategy 3: Annual Monitoring Near SJLF Stormwater Outfalls														
S-7	Smith Lake; western corner near landfill	1					1*							
S-14	Smith Lake: west corner near landfill	1					1							
		* transect of 3 samples collected at the specified station												



R L I S
REGIONAL LAND INFORMATION SYSTEM

Figure 1: Smith Bybee Lakes

Sediment
Monitoring Locations

Scale: 1" = 1600'
0 400 800 1200 1600

METRO

600 NE Grand Ave.
Portland, OR 97232-2736
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Email drc@metro.dst.or.us

97071/sediment.aml, plot date: September 09, 1997

STORM WATER

Table A
Stormwater Monitoring Parameters

Parameters are measured in storm water samples from St. Johns Landfill. For a given sampling parameters are selected based on the monitoring component being implemented. Parameters other than those listed below may be measured as warranted by objectives to be defined.

Conventionals	Nutrients	Biologicals	Total Recoverable Heavy Metals
Biochemical Oxygen Demand	Nitrate + Nitrite	Enterococci	Arsenic
Chemical Oxygen Demand	Total Phosphorus	Fecal Coliform	Barium
Conductivity	Ortho Phosphate (dissolved)	◆ E. coli	Beryllium
Total Organic Carbon			Cadmium
◆ Total Suspended Solids			Chromium
◆ Oil and Grease			Cobalt
◆ pH			◆ Copper
◆ Settleable Solids			Iron
☐ Floating Solids			Manganese
☐ Oil & Grease Sheen			Mercury
☐ Debris			Nickel
			◆ Lead
			Antimony
			Selenium
			Silver
			Thallium
			Vanadium
			◆ Zinc

◆ = semiannual sampling/analysis required under prospective 1200-Z Stormwater Discharge Permit
☐ = monthly visual observation required under prospective 1200-Z Stormwater Discharge Permit

Table B
Stormwater Monitoring Station Inventory
(see Figure 1)

Station	Outfall Type	Receiving Waters	Landfill Drainage Area	Year of Closure of Drainage Area *	Monitoring Required (by Permit) **	Monitoring Significance
R-1	sedimentation basin	Columbia Slough (main channel)	subareas 1,2,3	1992, 1994	monthly visual observation	construction of this outfall allows measuring storm water flow
R-2	culvert	North Slough arm	subareas 1	1992-1993	biannual analysis of grab sample	drains area where landfill cover is oldest
R-3	sedimentation basin	North Slough arm	subareas 4	1993, 1996	monthly visual observation	drains area which includes both relatively old and relatively new landfill cover
R-5	sedimentation basin	North Slough arm	subareas 4,5	1993, 1996	biannual analysis of grab sample	drains area where landfill cover was installed most recently
R-8	culvert	Smith Lake	subareas 5	1993, 1996	monthly visual observation	drains area where landfill cover is relatively new discharges to Smith Lake
R-10	sedimentation basin	Columbia Slough (main channel)	subareas 5	1995-1996	biannual analysis of grab sample	drainage includes motor blower flare facility
R-17	culvert	Columbia Slough (main channel)	subareas 3	1994	biannual analysis of grab sample	drains active sheep grazing area
R-21	sedimentation basin	Smith Lake	subareas 4 & 5	1994	biannual analysis of grab sample	relatively large drainage; discharges into Smith Lake

* Identifies year(s) during which landfill cover system was installed in the drainage area.

** Assumes 1200-Z Stormwater Discharge Permit proposed by DEQ to EPA; and approval by DEQ of the SJLF Stormwater Pollution Control Plan to be updated by Metro.

Table C
Storm Water Monitoring Schedule

SJLF Outfall Station ID *	Station Description	Sampling Events per year **	Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec
R-1	sedimentation pond: west flank													
R-2	culvert: northwest corner	2				1						1		
R-3	sedimentation pond: north flank													
R-5	sedimentation pond: northeast corner	2				1						1		
R-8	culvert: northeast corner	2												
R-10	sedimentation pond: southeast corner	2				1						1		
R-17	culvert: southwest corner	2				1						1		
R-21	sedimentation pond: southeast corner	2				1						1		

Notes: * Monthly visual observations for selected conventional parameters will be made at all 8 stations, per the proposed permit and an update SWPCP;
Six stations will be sampled twice per year, as indicated in the schedule.

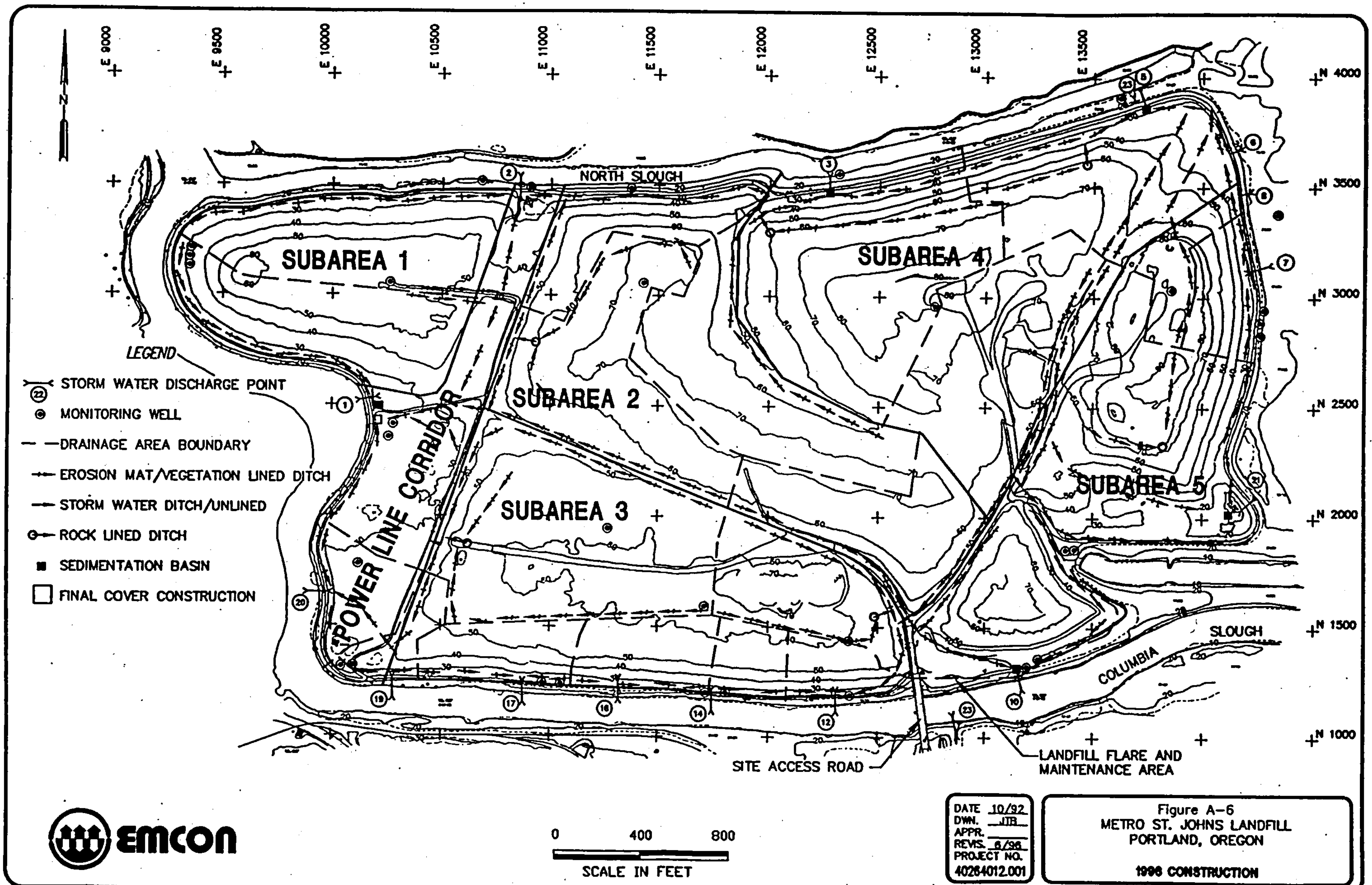
** Twice per year analysis of grab samples is consistent with NPDES Stormwater Discharge Permit 1200-Z: proposed by DEQ to EPA

Shading identifies time periods during which one sample will be collected from the indicated station.

Schedule does not reflect Strategy 2, for which monitoring requirements have yet to be specified.

Meeting the objectives of Strategy 3 does not require regularly scheduled sampling.

FIGURE 1
STORM WATER MONITORING LOCATIONS
ST. JOHNS LANDFILL



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Leachate Discharge

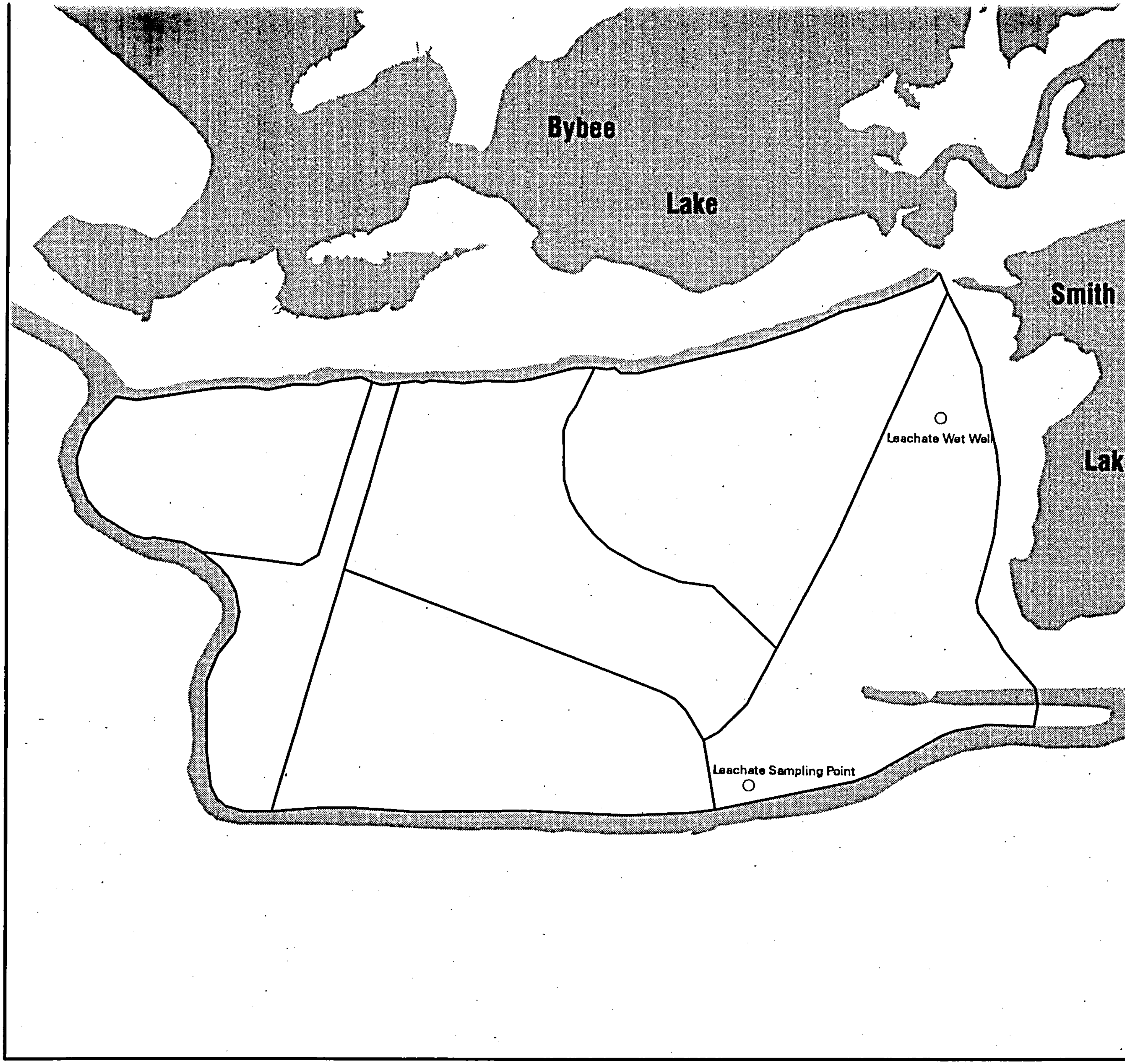
Table A
Leachate Monitoring Parameters

Parameters are measured in samples collected from the line which discharges St. Johns Landfill leachate to the City sanitary sewer system.
For a given sampling parameters are selected based on the SJLF Wastewater Discharge Permit monitoring schedule.
Parameters other than those listed below may be measured as warranted by changes in the Permit or other objectives to be defined.

Conventionals	**Total Heavy Metals**	**VOC**	**SVOC**	**SVOC**	**Pesticides**	**PCBs**
pH	Cadmium	1,1,1-trichloroethane	1,2,4-trichlorobenzene	Di-n-butylphthalate	Alpha BHC	Aroclor 1016
Total Oil and Grease	Chromium	1,1,2,2-tetrachloroethane	1,2-dichlorobenzene	Di-n-octyl phthalate	Lindane	Aroclor 1221
Flash Point	Copper	1,1,2-trichloroethane	1,3-dichlorobenzene	Dibenzo(a,h)anthracene	Heptachlor	Aroclor 1232
Ammonia Nitrogen	Iron	1,1,2-trichloroethylene	1,4-dichlorobenzene	Dibenzofuran	Aldrin	Aroclor 1242
Total Petroleum Hydrocarbon	Lead	1,1-dichloroethane	2-chlorophenol	Diethylphthalate	Beta-BHC	Aroclor 1248
Total Phenol	Mercury	1,1-dichloroethylene	2,4,5-trichlorophenol	Dimethylphthalate	Delta-BHC	Aroclor 1254
	Nickel	1,2-dichloroethane	2,4,6-trichlorophenol	Fluoranthene	Heptachlor epoxide	Aroclor 1260
	Zinc	1,2-dichloroethylene	2,4-dichlorophenol	Fluorene	Endosulfan I	
		1,2-dichloropropane	2,4-dimethylphenol	Hexachlorobenzene	Endosulfan II	
		2-butanone (MEK)	2,4-dinitrophenol	Hexachlorobutadiene	Endosulfan sulfate	
		2-hexanone	2,4-dinitrotoluene	Hexachloroethane	pp-DDE	
		4-Bromofluorobenzene	2,6-dinitrotoluene	Hexachlorocyclopentadiene	pp-DDD	
		4-methyl-2-pentanone (MIBK)	2-chloronaphthalene	Indeno(1,2,3-cd)pyrene	pp-DDT	
		Acetone	2-methylnaphthalene	Isophorone	Endrin	
		Bromodichlormethane	2-methylphenol	N-nitrosodimethylamine	Endrin aldehyde	
		Benzene	2-nitroaniline	N-nitrosodiphenylamine	Methoxychlor	
		Bromoform	2-nitrophenol	N-nitroso-di-n-propylamine	Toxaphene	
		Bromomethane	3,3-dichlorobenzidine	Naphthalene	Chlordane	
		Chlorodibromomethane	3-nitroaniline	Nitrobenzene		
		Carbon disulfide	4,6-dinitro-2-methylphenol	Pentachlorophenol		
		Carbon tetrachloride	4-bromophenyl-phenylether	Phenanthrene		
		Chlorobenzene	4-chloro-3-methylphenol	Phenol		
		Chloroethane	4-chlorophenyl-phenylether	Pyrene		
		Chloroform	4-chloroaniline	bis-(2-ethylhexyl)phthalate		
		Chloromethane	4-methylphenol	bis-(2-chloroethyl)ether		
		Ethyl benzene	4-nitroaniline	bis-(2-chloroethoxy)methane		
		Methylene chloride	4-nitrophenol	bis-(2-chloroisopropyl)ether		
		Styrene	Acenaphthene			
		Tetrachloroethylene	Acenaphthylene			
		Toluene	Aniline			
		Trichlorofluoromethane	Anthracene			
		Vinyl acetate	Azobenzene			
		Vinyl chloride	Butylbenzylphthalate			
		Xylenes (total)	Benzo(a)anthracene			
		cis-1,3-dichloropropene	Benzo(a)pyrene			
		p-dichlorobenzene	Benzo(b)fluoranthene			
		trans-1,3-dichloropropene	Benzo(g,h,i)perylene			
			Benzo(k)fluoranthene			
			Benzidine			
			Benzoic acid			
			Benzyl alcohol			
			Chrysene			

Table B
Leachate Monitoring Schedule

Station ID	Station Description	Sampling Events per year	Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec
Leach-Samp	leachate pipeline to sewer	12	1	1	1	2*	1	1	1	1	1	1	2*	1
	(valve at Landfill bridge)													
		Schedule is consistent with Industrial Wastewater Discharge Permit 400.018: BES												
		* one priority pollutant scan of composite sample; and one grab sample for NH3 and pH only; all other samples during year are grabs for NH3 and pH.												



R L I S
REGIONAL LAND INFORMATION SYSTEM

Figure 1
St. Johns Landfill

Leachate Wet Well &
Discharge Sampling Locations

Subarea Boundaries

N E S W

Scale: 1" = 750'

0 250 500 750 1000

METRO

600 NE Grand Ave.
Portland, OR 97232-2736
Voice 503 797-1742
FAX 503 797-1909
Email drc@metro.dst.or.us

SAMPLING AND ANALYSIS

GROUNDWATER SAMPLING DATA SHEET
ST. JOHNS LANDFILL

Well ID: ____________ Duplicate Sampling Site:______________ Priority Pollutant Sampling Site:_________
Weather Conditions: ________________________________
Observation and Condition of Well: ________________________________
____

Date	Time	Purge Method	Recharge Rate
/ /	:		

DTB	DTW	(Water Column) DTB - DTW	(Water Column x Gal/ft) Volume (gal)	(Gal x 3) Purge Volume	(Purge Vol. / Bailer Vol.) # of Bailer Pulls
.	.	.	.	.	

Well Diameter (in.)	Gallons / Foot
2	0.163
3	0.367
4	0.653

Bailer Size	Bailer Volume (gal)
4 ft x 2 in	0.35
5 ft x 2 in	0.54
5 ft x 3 in	0.87

Field Parameteres
Field Instrument:______________________

Time	Purge Vol.	Temp (F)	pH	Cond	DO-%	DO	Redox	Salin
:		.	.			.		.
:		.	.			.		.
:		.	.			.		.

Sample Collection:
1. Bottles contain preservative: __________
2. Correct parameters field filtered: __________
3. Samples stored on ice: __________

Comments:____
____

Samplers: ______________________

____

SURFACE WATER SAMPLING DATA SHEET
SMITH-BYBEE LAKES WILDLIFE AREA

Date: ___________
Site: ___________
Weather Conditions: (air temp, wind) ______________________________
Tide: ______________
Water Color & Condition: ______________________________
Sample Depth: ____________
Total Depth: ____________

Field Parameters

Field Instrument: ____________________
Time: ___________
Instrument Depth: ____________
Temperature: ____________
pH: ___________
Conductivity: ___________
DO-%: ____________
DO: ____________
Redox: ____________
Salinity: ____________
Sechi Disk: ____________

Sample Collection:

1. Bottles contain preservative: ______
2. Correct parameters field filtered: ______
3. Samples stored on ice: ______

Comments:____

____

____

Samplers: ________________________

____

SEDIMENT SAMPLING DATA SHEET
SMITH-BYBEE LAKES WILDLIFE AREA

Date: ___________
Time: ___________
Site: ___________
Site Description: ____
Weather Conditions: ______________________________
Wind Conditions: ____________________
Depth to Bottom: ____________
Sediment Characteristics: ______________________________________
Sample Type: _____________

Sample Collection:

1. Bottles contain preservative ________
2. Samples stored on ice (if necessary) ________

Comments: ____

____

Samplers: ______________________

____

STORMWATER SAMPLING DATA SHEET
ST. JOHNS LANDFILL

Site: ___________
Date: ___________
Time: ___________
Weather Conditions: (air temp, wind) ______________________________
Rainfall (intensity, duration): ________________
Water Color and Condition: ____
Sample Type: ____________

Field Parameters

Field Instrument: ______________________
Time: _____________
Instrument Depth: _______________
Temperature: ________________
pH: ____________
Conductivity: ______________
DO-%: _______________
DO: _________________
Redox: _______________
Salinity: ______________

Sample Collection:

1. Bottles contain preservative: _______
2. Correct parameters field filtered: _______
3. Samples stored on ice: _______

Comments:____
____

Samplers: ___________________________

____

LEACHATE DISCHARGE SAMPLING DATA SHEET
ST. JOHNS LANDFILL

Site: __________
Date: __________
Time: __________
Leachate Color and Condition: ______________________________
Sample Type: ____________

Sample Collection:

1. Bottles contain preservative: _______
2. Samples stored on ice: _______

Comments: ______________________________

____

Samplers: ______________________

____