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Revised Closure & Financial Assurance Plan

For the St. Johns Landfill
August 1989

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TABLE OF CONTENTS

I. INTRODUCTION

A. Closure Plan Background

Modern methods of sanitary landfill operation involve not only burying solid waste but using the waste itself to build a structure designed to reduce negative impacts on health, safety, and the environment. Closing a sanitary landfill means the process of finishing the construction of this designed structure so that it best performs its protective function. In the case of St. Johns Landfill, closure means finishing the construction of an old landfill, much of which was built before current environmental standards were in effect.

Oregon State Law requires that the permit holder apply to renew a solid waste permit at least five years before the proposed closure of a land disposal site. The applicant must provide proof of satisfactory financial assurance to cover the cost to install and operate all environmental protection and monitoring systems during closure and for ten or more years after closure.

To comply with those requirements, Metro submitted on January 9, 1986, a draft closure and financial assurance plan to the Department of Environmental Quality (DEQ) staff for comment. After comments were received from DEQ in late 1986, Metro submitted on December 16, 1986 a closure and financial assurance plan with its formal application for a closure permit. The plan estimated that costs associated with closure and post closure activities would total 5.8 million dollars. All but $92,000 would come from Metro.

Although DEQ staff initially indicated that the application appeared complete, it pointed out that the application would need modification after the City of Portland completed its end use plan in June 1987. Also, during the succeeding months a report called Smith and Bybee Lakes Environmental Studies raised questions about the hydrogeology under St. Johns Landfill and the landfill's impact on the environment.

In October 1987 a letter from the DEQ director notified Metro that additional information would be required. Among the information requested was a complete review of ground and surface water monitoring as well as the sampling of selected groundwater monitoring wells for priority pollutants. In July 1988 DEQ issued Solid Waste Disposal Site Closure Permit #116 which included a compliance schedule, leading to submission by Metro of a revised closure and financial assurance plan.

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. During the closure process Metro desires to (1) close the landfill property, (2)

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positively integrate the landfill into the surrounding wetland, (3) provide opportunity for research about closure methods and results and (4) provide opportunities to recycle wastes.

Therefore, Metro responded to the DEQ request by investigating the impact of St. Johns Landfill on the surrounding environment. This information would be used to identify options to close the St. Johns Landfill in a cost effective manner, mitigating negative impacts. In July 1988 Metro hired Sweet-Edwards/EMCON, Inc. to perform hydrogeologic and engineering investigations of the St. Johns Landfill in connection with the closure process. Representatives of DEQ and the City of Portland assisted Metro in selecting this technical consultant.

This revised closure plan is based upon and references a four volume report by Sweet-Edwards/EMCON, Inc. (SE/E) in May and July 1989. This report, titled St. Johns Landfill Water Quality Impact Investigation and Environmental Management Options is submitted to DEQ with this closure plan. This revised closure plan is intended to meet Metro's closure objective and is submitted in compliance with the DEQ closure permit.

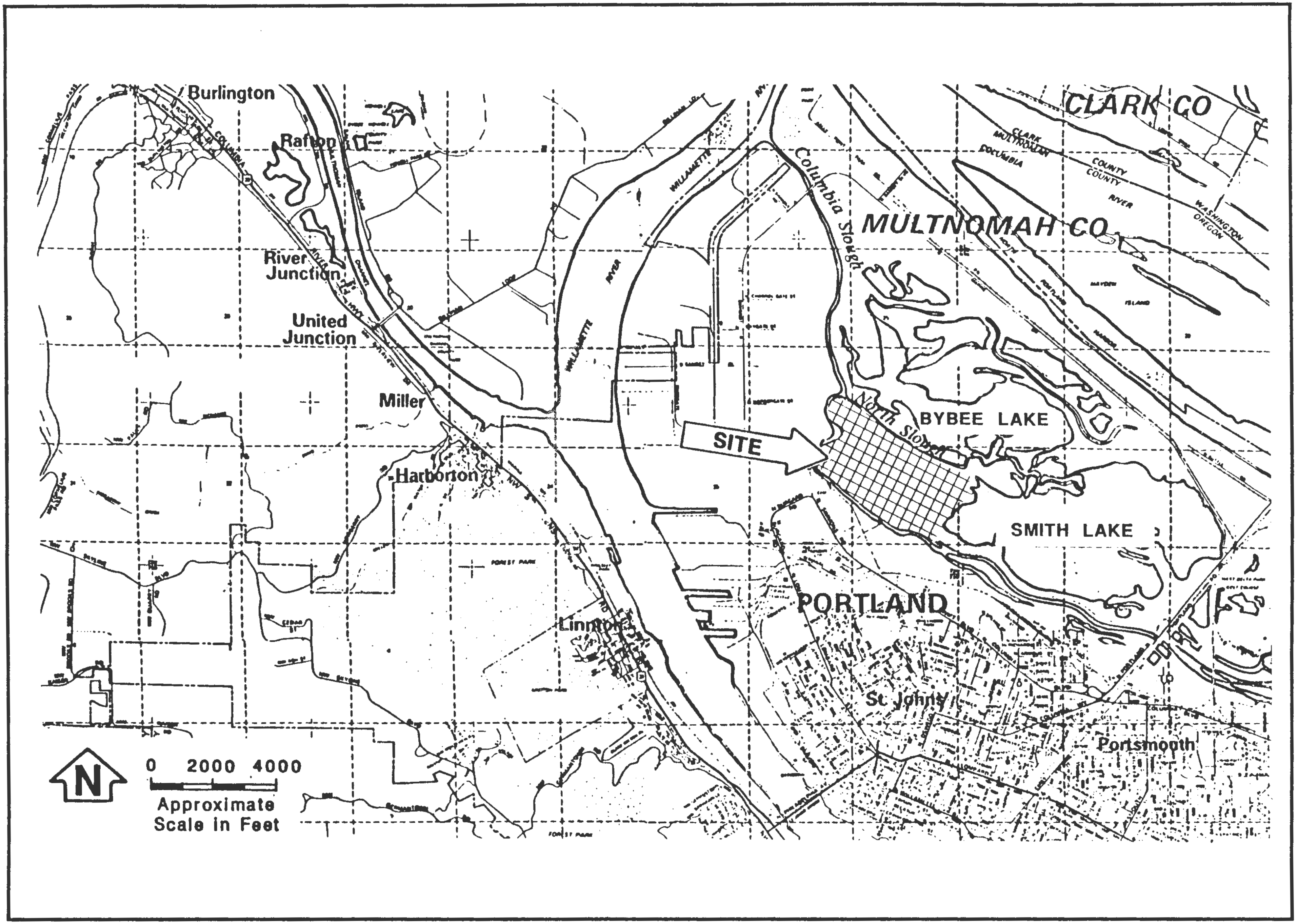
B. St. Johns Landfill History

The St. Johns Landfill is located in the Northwest Portland rivergate area near the confluence of the Columbia and Willamette Rivers (Fig.1). In 1939 the City of Portland built a bridge across the Columbia Slough and began to fill with solid waste the 193-acre site northeast of Columbia Slough. Before being filled with solid waste the site was a marshy lake [1]. Reportedly, early operations received almost any type of waste including petroleum and chemical sludges, stumps, incinerator ash, demolition debris, and household and commercial wastes [2]. Some of the wastes, acceptable at the time, are now considered hazardous wastes unacceptable in a municipal landfill [3]. From the beginning of the 1970's, the landfill was operated as a sanitary landfill with no burying of waste and with compaction of the waste followed by a covering of earth [4]. Also, at this time the adjacent City-owned solid waste incinerator was shut down and ceased to be a source of ash.

In June 1980, the Metropolitan Service District took over operation of the St. Johns Landfill under lease from the City of Portland. Metro carried out an operations plan previously commissioned by the City. The plan provided that the older 193-acre portion receive final layers of waste followed by two feet of final cover, and that a 55-acre expansion area be constructed and filled with solid waste. Currently solid waste related activities are carried out on 255 acres of land - 19 acres southwest of the Columbia Slough is used for the gatehouse, public transfer station, and yard debris storage, and 236 acres northeast of the Columbia Slough where waste has been buried since 1939.

Since 1980, Metro has set and collected dumping fees and has supervised the actual construction of the landfill by private contractors. Metro operates the site under Solid Waste Disposal Site Closure Permit #116 and NPDES Waste Discharge Permit #100599. These are issued by the Oregon Department of Environmental Quality.

A series of aerial photos beginning in 1932 shows the physical features of the site prior to filling and shows the construction of the landfill since then [5].



St. Johns Landfill Site Location Map

Figure 1

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C. Impact on Ground and Surface Water

Based on the results of past hydrogeologic investigations it appears that solid waste disposal for half a century at the St. Johns Landfill has resulted in some degradation of surface water and ground water quality at or near the site. However, the apparent extent of degradation is lower than might be expected given the age of the landfill and the lack of engineered environmental protection facilities in all areas except the expansion area. This lower level of degradation appears to be due to natural processes and geologic features which protect the environment to some degree.

Surface water quality of St. Johns Landfill impacts to North Slough and Columbia Slough do not appear to be significant [6]. This is apparently due to the fact that leachate (contaminated water) release to surface waters is limited by the relatively low permeability of the natural levees and engineered dikes which surround the landfill and also by the fold dilution by Willamette River water that enters and flushes North Slough and Lower Columbia Slough with each tidal cycle, for example dilution in North Slough appears to be 2000 to 10,000 fold [7]. Even under the low water conditions of late summer and fall months, these factors appear to limit surface water quality impacts In North Slough, for example, flushing by tidal action and surface water flow has prevented significant degradation of water quality despite the historic and continuing discharge of landfill leachate seeps and leachate contaminated ground water and surface water runoff. Also, sediment samples from North Slough showed little evidence of metals contamination, showed no toxicity in bio-assay tests conducted by the Department of Environmental Quality and appeared to be of significantly better quality than sediment samples collected from Lower Columbia Slough [8]. Impacts to the water quality of Columbia Slough from sources other than the landfill appear to be much greater than those attributable to the landfill.

The ground water in the shallow flood plain sediments and the deeper pleistocene sands and gravel beneath the landfill has apparently been contaminated by leachate from the landfill [9]. Shallow water in the flood plain sediments and to a lesser degree the pleistocene gravel aquifer northeast and northwest of the site appears have been affected by leachate from the landfill [9]. Secondary (taste and odor) drinking water standards for iron and manganese were exceeded in samples in all 20 wells tested for these parameters.

Four offsite wells in the gravel aquifer were analyzed for substances governed by the primary drinking water standards. The total coliform standard was the only standard exceeded. It is not known whether these coliform microorganisms are from the landfill, from another source, or simply the result of surface contamination during the monitoring well drilling or sampling process.

Contaminants (principally volatile organic compounds) were identified in some monitoring wells located south and east of the landfill. Although present at low levels, some exceeded maximum concentration limits for drinking water. Several pieces of evidence suggest that the volatile organic compound contamination may be from a source other than the landfill [10]. No significant levels of pesticides, herbicides, heavy metals, and other priority pollutants were detected.

The leachate from St. Johns landfill contains higher levels of total nitrogen than the area groundwater. If groundwater contaminated with nitrogen migrated to Bybee Lake, it could potentially add to the eutrophication of this lake. However, the elevation maintained for Bybee Lake (10.5 to 11 feet mean sea level [MSL]) appears to be preventing the flow of leachate contaminated ground water through the flood plain sediments to the Lake [11]. Also, there appears to be no short term benefit to flushing Bybee Lake via Columbia Slough since the slough water would also add to lake eutrophication. Therefore, Bybee Lake should be held at an elevation between 10.5 and 11.5 feet MSL to minimize the risk of leachate contamination.

Leachate from the landfill expansion area would not be expected to migrate through the groundwater to Smith Lake. Elevations of the lower leachate collection trenches in the expansion area range from a high of 10.3 to a low of 5.5 feet MSL [12] below the elevation at which Smith Lake is held. Thus, if the leachate mound in the expansion area is kept below the elevation of Smith Lake, there would be an inward gradient of groundwater from the Smith Lake to the expansion area waste rather than vice versa.

A field survey was performed to identify uses of groundwater surrounding St. Johns Landfill [12]. No beneficial uses of ground water were identified in the flood plain sediments in the area completely surrounding the landfill. Several non-consumptive use wells and one consumptive use (drinking water) well take water from the pleistocene gravel aquifer below the flood plain sediments.

The primary mechanism is similar for both ground and surface water contamination. A significant amount of rain water enters the buried solid waste by percolating through the clay cover soil. The water percolates through the solid waste and leaches out contaminants. This water moves slowly downward into the ground water through the sediments underlying the solid waste and slowly sideways toward surface water through the natural or engineered levees. Since those sediments are of low permeability they retard liquid flow. Thus a leachate mound develops in the landfill which drives the downward and outward movement of contaminated water. It is estimated that approximately 90% of the leachate moves downward [13]. This mechanism of contamination suggests a primary method to control ground and surface water contamination. To control contamination one should interfere with leachate generation by blocking rain water percolation through the cover into the solid waste. This method will be presented in the information that follows.

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II. CLOSURE PLAN ELEMENTS

A. Final Grading Plan

SUMMARY

Final grading promotes runoff of rainfall rather than its percolation into the waste, directs rainfall runoff to surface water control structures, provides adequate volume for refuse, and provides for construction of permanent roads through the landfill to allow access for maintenance and repair of facilities for monitoring, operation, and maintenance.

DRAINAGE AND ADEQUATE FILL VOLUME:

1. Regrading to minimum 5% slopes, as follows:

   - Subarea 1 and the powerline corridor, as shown in Figure 2 [14], would be regraded with soil or similar material to provide acceptable 5% minimum slopes for good long-term drainage [15]; and

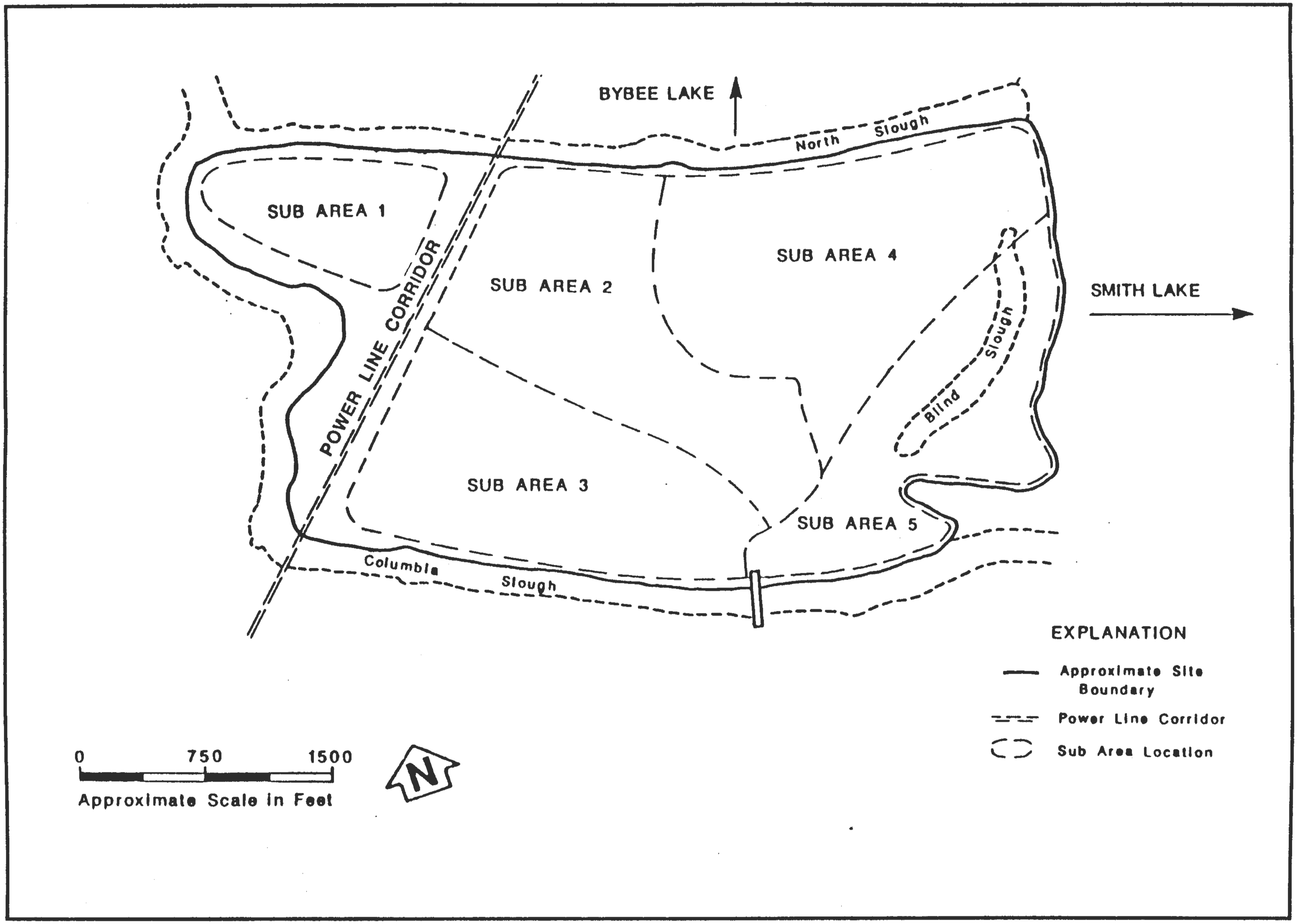
   - Subarea 3 would be regraded with garbage and increased to no more than 80 feet maximum elevation (before final cover). This would achieve 5% to 10% initial slopes to improve drainage and provide adequate fill volume [16]; and

   - Subarea 4 would be regraded with garbage and increased to no more than 88 feet maximum elevation (before final cover). This would achieve 5% to 10% initial slopes to improve drainage and provide adequate fill volume [17]; and

   - Subarea 5 would be filled to a height which achieves minimum 5% slopes when burial of waste ceases.

PERMANENT ACCESS ROADS:

2. North-south and east-west access roads suitable for post closure maintenance would be constructed [18]. The existing perimeter roads would be maintained.



METRO *St. Johns Landfill Sub Area Boundaries* Figure 2

RATIONALE

DRAINAGE AND ADEQUATE FILL VOLUME

Grading of the landfill is a means of obtaining proper slopes for long-term stormwater drainage. Because waste within the landfill will biologically decompose over time at different rates, resulting settlement will vary at different locations. Normal refuse decomposition and settlement will reduce the final grade elevation over time from several percent to as much as 30 percent of the fill thickness [19]. This differential settlement leads to ponds of stormwater on the landfill surface if the grading is not to an adequate slope. Ponding encourages rainwater percolation into the solid waste. In general 5% minimum slopes were considered adequate for the top of the subareas and 20 to 25% grades were used for the sideslopes [20]. The following information relates to the subareas shown in Figure 2.

SUBAREA 1

Existing Conditions in Subarea 1. Solid waste refuse filling in Subarea 1 ceased around August 1981, and cover was placed and shaped during September and October 1981 [21]. As noted by EMCON Associates during their 1989 landfill inspection, here is currently some ponding occurring within Subarea 1. Regrading is recommended to eliminate the ponds and improve drainage [22].

Analysis of Proposed Conceptual Plan in Subarea 1. The proposed grading would involve placing approximately 18,000 cubic yards of earth or similar fill on top of the area to achieve minimum 5% slopes [23]. The use of additional refuse for fill was not contemplated because the depth of fill to achieve the proposed slopes is shallow, ranging from 1 to 4 feet [24].

POWERLINE CORRIDOR

Existing Conditions in the Powerline Corridor. As noted by EMCON Associates during their 1989 annual landfill inspection report water is ponding in the power line easement and potentially contributing to leachate production, requiring regrading [25].

Analysis of Proposed Conceptual Plan in the Powerline Corridor. In the proposed plan, minor grading would be performed to eliminate the ponds and improve surface water runoff from the area. The majority of the area would receive 1 to 3 feet of earth or similar fill (approximately 40,000 to 50,000 cubic yards). The southern end would require at least 4 feet of fill, equating to 6,000 to 8,000 cubic yards. In addition to the general grading constraints, there are additional criteria from PGE and BPA limiting the ground surface elevation near the power line towers [26]. Furthermore, drainage must not pond around the towers and drainage ditches must not prevent access to the towers [27].

SUBAREA 2

Existing Conditions in Subarea 2. From December 1987 through November 1988, additional refuse was placed in Subarea 2 [28]. The Subarea 2 refill was based on design grades updated November 1987 [29].

Analysis of Proposed Conceptual Plan in Subarea 2. The slopes in the area generally range from 6 to 25% [30]. Minor grading would be performed to smooth the existing slopes, and minor filling would be performed to eliminate flat areas along the peak of the hill and create minimum 5% slopes [31]. Subarea 2 would not receive additional refuse [32]. Minor cutting of refuse along the southern boundary of the area will be needed to reduce 40% slopes to 25% [33].

SUBAREA 3

Existing Conditions in Subarea 3. By April 1986, Subarea 3 was filled with refuse and cover was placed [34]. Since that time differential settlement has occurred, creating numerous ponded areas [35].

Analysis of Proposed Conceptual Plan in Subarea 3. The final design grades proposed for Subarea 3 after refilling with refuse will achieve minimum 5% minimum slopes and provide additional disposal volume [36]. If the final refuse elevation were set at elevation 80 feet MSL, the depth of refuse would range from 8 to 18 feet and the area may be filled efficiently due to a reasonable depth of refuse space available [37]. Top of final cover, approximately 4 feet thick, would be 84 feet MSL [38]. The disposal volume would increase approximately 200 thousand cubic yards compared with the existing approved final grades. In order to fill to this elevation, however, permission from the City of Portland would be required, as a present policy limits the overall height of the landfill to elevation 80 feet MSL [39]. Subarea 3 would settle, however, to below the 80-foot elevation after decomposition and final stabilization of the waste materials [40].

SUBAREA 4

Existing Conditions in Subarea 4. Erosion and ponds were observed in Subarea 4 (including the "cat tracks" in the future end use "parking lot" area and the "toe ditch" area) during EMCON's June 1989 landfill inspection [41].

Analysis of Proposed Conceptual Plan in Subarea 4. The final design grades proposed for Subarea 4 after refilling with refuse will also achieve minimum 5% top slopes and provide additional disposal volume [42]. In this case, if the final refuse elevation were set at elevation 88 feet MSL, the top of the approximately 4 feet thick final cover would be 92 feet MSL [43]. The disposal volume would increase approximately 200 thousand cubic yards compared with the existing approved final grades. In order to fill to this elevation, as in Subarea 3, permission from the City of Portland would be required, as a present policy limits the overall height of the landfill to elevation 80 feet MSL [44]. If in Subarea 4 the height limitation were not exceeded, the top slope grades would be reduced from the recommended 5 percent minimum to 3 percent, leading to ponding and vegetation problems [45]. An exemption to the height limitation is necessary to achieve better final grades and more efficient use of disposal areas [46]. Subarea 4 also would settle to below the 80-foot elevation after decomposition and final stabilization of the waste materials [47].

SUBAREA 5

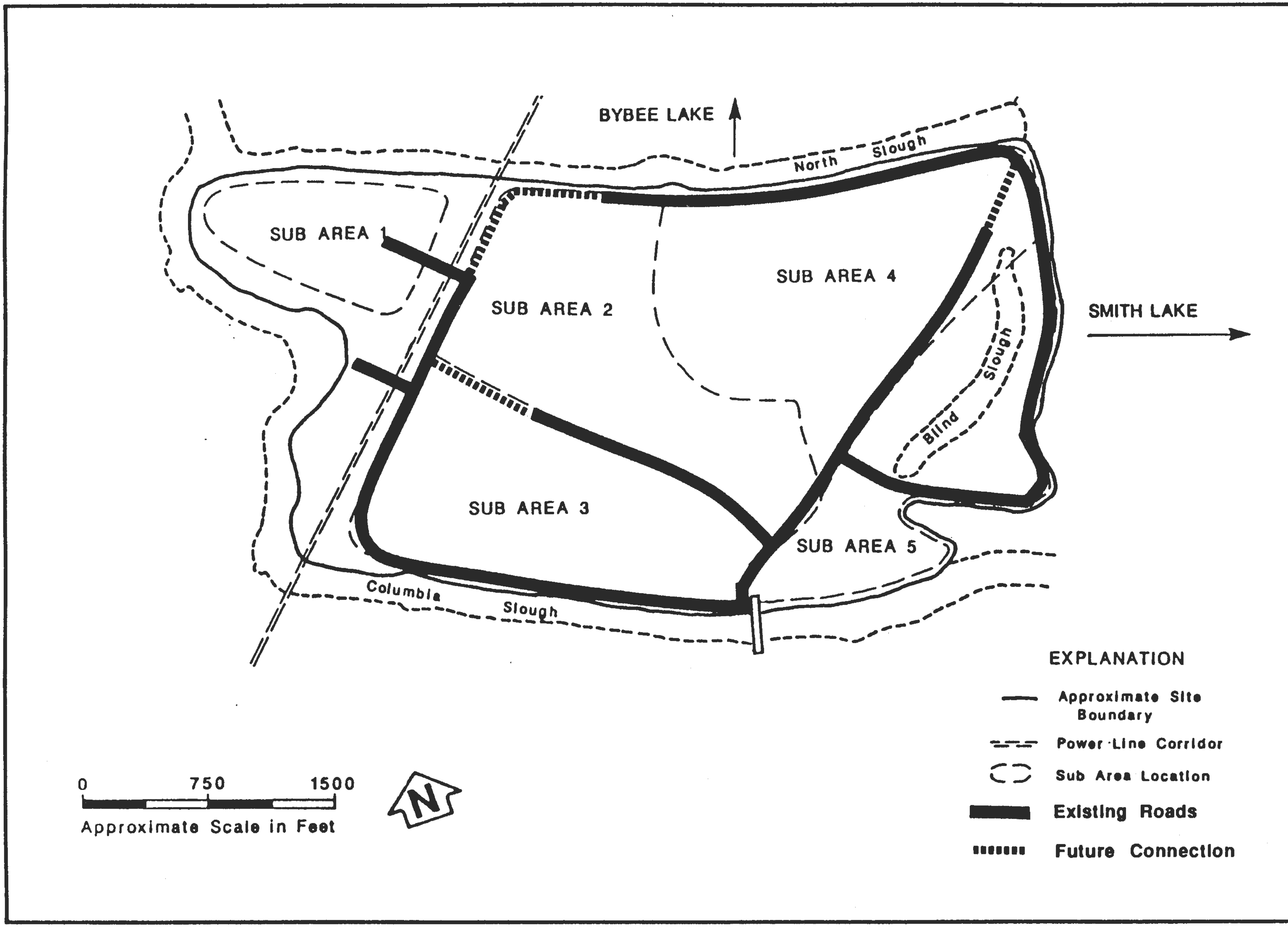
Existing Conditions in Subarea 5. Portions of Subarea 5 received waste prior to 1980. A portion of Subarea 5 in the expansion area is currently being filled with waste.

Analysis of Proposed Conceptual Plan in Subarea 5. The final grades in Subarea 5 could be varied to account for changes in refuse volume needed, if the height of fill in Subarea 3 and Subarea 4 is increased. If less disposal volume were needed, the height of the area could be reduced and a minimum 5% top slope still retained [48].

PERMANENT ACCESS ROADS

Existing Conditions. See existing ronds in Figure 3.

Analysis of Proposed Conceptual Plan. Roads will be maintained around the site perimeter as they currently exist [49]. Future road connections will be constructed between Subareas 4 and 5 and between Subareas 2 and 3 to achieve a road system which performs following access-related functions: final cover inspection and maintenance; inspection and adjustments of the leachate collection and landfill gas control systems; and drainage facility maintenance [50]. Depending on the leachate control alternative employed, additional perimeter roads may be required for access purposes around Subareas 1 and 2 [51]. Gravel foot paths adjacent to side slope ditches will be incorporated into the design, if required to provide access to the landfill gas extraction system and leachate collection facilities [52].



METRO *St. Johns Landfill Road System* Figure 3

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B. Final Cover

SUMMARY

The final cover limits the amount of rainwater seeping into the garbage, provides a stable surface for stormwater runoff, and controls the release of landfill gas [53].

FINAL COVER

1. A plastic cover (or geomembrane) would be used over the entire landfill [54].

2. The final cover profile would consist of the following [55]:

12"	Topsoil (soil and compost) to support vegetation
8 oz.	Geotextile to prevent topsoil from clogging drainage material
12-18"	Drainage material (rock) to carry away rainwater percolating through topsoil
40-60 mil	Geomembrane plastic cover a barrier to rainwater and gas
12"	Drainage layer (sand) to carry away rising gas to the gas collection wells or trenches (tentative)
6"	Minimum of cover material (soil) over the solid waste

3. Haul ronds and other areas will be frequently watered as necessary to reduce dust during cover placement.

RATIONALE

FINAL COVER PROFILE

Existing Final Cover. At present, final cover throughout much of the landfill consists of topsoil or a mixture of digested sewage sludge and seeded topsoil 6 inches thick on top of 18 inches of clay over 6 inches of daily cover [56].

The Leachate Mound. A significant amount of water enters the landfill annually as a result of downward percolation of rainfall. This percolation, in combination with the low permeability of the floodplain sediments that surround the landfill, has resulted in the development of a leachate mound (contaminated groundwater mounded above the original groundwater table) within the landfill [57]. Leachate releases to ground and surface waters typically result in the most significant environmental impacts associated with landfills [58]. Past records show the leachate mound in Subareas 1, 2, and 3 has remained at a fairly constant level over the past 15 years [57,59].

How the Final Cover Effects the Leachate Mound. Due to final cover placement the percolation of rainwater will be nearly eliminated and the leachate mound will begin to decrease as leachate migrates downward and laterally. It is estimated that the leachate mound will decline to the level of the surrounding groundwater in seven years [60]. As the height of the leachate mound decreases, so will the rate of discharge to the underlying silts [61].

Description of Proposed Final Cover Scheme. The geomembrane cover, as shown in Figure 4, incorporates a 40 millimeter (mil.) to 60 mil. thick geomembrane with drainage layers above and below it, and a vegetative planting layer as a surface cover to

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reduce erosion. A geotextile is included between the vegetative and drainage layers to prevent fires from migrating into, and plugging, the drainage layer. The geomembrane may consist of either high density polyethylene (HDPE) or medium density polyethylene. The granular drainage layer below the geomembrane provides for flow of landfill gas to extraction wells and leachate collection from side slope seeps [62]. This drainage layer may not be necessary, more investigation will be done to determine if it is necessary. The drainage layers of sand and gravel below and above the geomembrane would be well-graded and have a permeability of at least 5×10^{-2} cm/sec. The use of synthetic drainage nets would not be incorporated into the cover profile as they do not provide as much of a factor of safety against sliding as is provided by the sand and gravel [63]. On slopes steeper than 20 percent, a textured surface geomembrane would be used to provide an acceptable factor of safety against slippage of the cover soil [64].

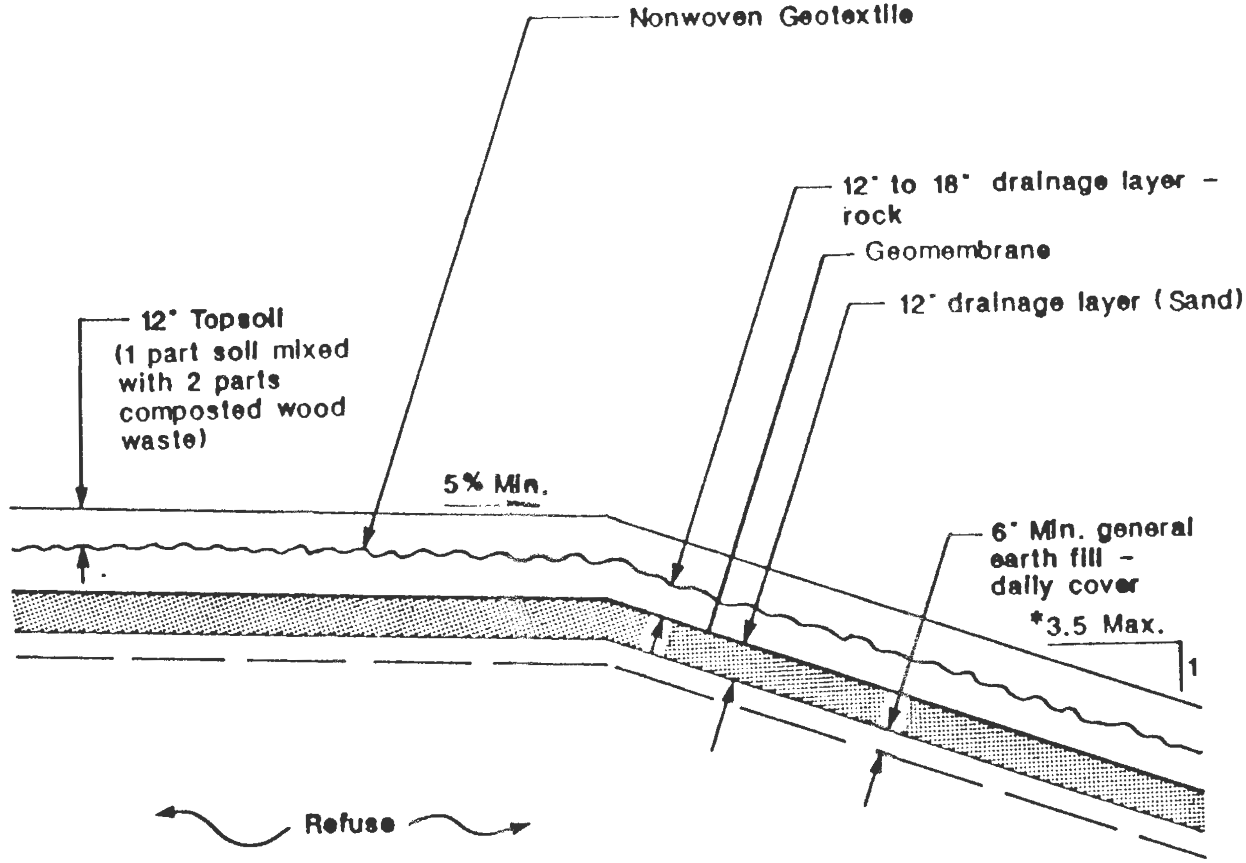
Geomembrane vs Clay Cap. Rainfall percolation into the refuse can be almost completely eliminated by using a geomembrane final cover system, reducing the overall volume of leachate generated by an estimated factor of 5000 compared with a 10-30% reduction for clay [65]. Another disadvantage of a clay cover system is that cracks in the cover system occur due to settlement of the waste over time [66]. Rainwater directly enters the waste through these cracks. The use of a geomembrane, as opposed to low-permeability clay, also presents some disadvantages: the potential for slippage of soil placed on the geomembrane, the accumulation of water on top of the geomembrane which must be drained, and landfill gas build-up under the geomembrane which must be channeled to a gas collection system [67]. Furthermore, a clay-type soil cover is less expensive and several Subareas already have some clay in place [68].

Evaluation of Infiltration through the Final Cover. Sweet-Edwards/EMCON evaluated final cover performance using a computer model developed by the U.S. Army Corps of Engineers for the Environmental Protection Agency (EPA). The model, the Hydrological Evaluation of Landfill Performance (HELP II), uses the relationship among rainfall, temperature, vegetation, soil types, and landfill construction to estimate the volume of leachate produced by the landfill [69]. The geomembrane final cover showed significantly less infiltration than the low-permeability clay when profiles, otherwise identical, were modeled [70]. A geomembrane cap, as modeled by Sweet-Edwards/EMCON (with an assumed .0001 leakage factor), results in leachate generation of almost zero [71]. Whereas, in contrast, modeling the same cover profile with 30" of clay replacing the geomembrane, generates approximately 4.5 inches of leachate [72].

Air Quality Impact of Installing Final Cover. The most significant air emissions from closure construction at St. Johns Landfill are fugitive dust emissions resulting from cover hauling and placement. These emissions were estimated using a dispersion model for fugitive dust sources [73].

The results indicate that the total suspended particulate concentration near the southern boundary could exceed the 24 hour secondary air quality standard if no dust control efforts are made. However, all assumptions are highly conservative and likely over predict actual valves.

At a minimum, use of a water truck with frequent daily watering will reduce dust emissions from 50% to 90%. These control levels result in dust emissions from St. Johns Landfill activities which are well below the air quality standard. Since the proposed cover will consist mostly of plastic geomembrane, rock and sand the dust emissions should be lower than from current placement of clay final cover.



* For textured membrane.

METRO *St. Johns Landfill Final Cover Using Geomembrane* Figure 4

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C. Stormwater Management

SUMMARY

Stormwater management will protect the final cover and the surrounding surface water. [74].

DRAINAGE ELEMENTS

1. Plastic-lined ditches, upper slope ditches, and drain pipes are used to collect and carry rainwater runoff to culverts connected to the surrounding sloughs [75].

STORMWATER QUALITY

2. Stormwater sedimentation collection ponds would be included to retain sediment generated from the cap, especially during the cap's construction phase [76], after closure the flow in the surrounding sloughs will be augmented with storm water of higher quality than the water they are currently carrying.

RATIONALE

Collection and discharge of stormwater is necessary to avoid erosion of the cap and minimize percolation of surface water into the solid waste [77].

CONCEPTUAL DRAINAGE ELEMENTS

Overview. Runoff generated from the final cap will be directed to the surrounding sloughs with an extensive drainage network comprised of lined ditches, culverts, and flow measuring flumes, as well as sediment retention ponds. Proper construction of these elements will ensure: (1) minimal percolation of stormwater into the solid waste, and (2) that surface runoff from the landfill entering the slough is of superior water quality to that in the sloughs [78]. This landfill surface runoff will beneficially augment flow in the sloughs.

Design Criteria. The stormwater management facilities design is based on criteria more conservative than the proposed EPA Subtitle D guidelines. Computed discharge rates, for each of the drainage areas within the landfill, were used to design the stormwater management elements [79].

Lower Lined Ditches. The perimeter of each drainage area will have a lined ditch and lined ditches will be constructed on either side of the main access roads across the landfill (referred to as lower ditches). The lower drainage ditch is designed to be 9 feet wide and 2 feet deep with a riprap and soil bottom lined with HDPE [80].

Existing Drainage Elements. Upper drainage ditches will be employed where there are breaks in slope from the minimum 5 percent top slopes to the approximately 20% side slopes. The upper drainage ditches are designed to be 6 feet wide and 1 foot deep and to intercept the drainage layer with an HDPE liner and perforated pipe [81].

Flumes. Flumes are connecting ditches. Six-inch perforated drainage pipe will be laid in the drainage layer of the landfill's top cap wherever the slope is 5 percent or less and a reach of 200 feet or more with no drainage ditches exists. This drain pipe, referred to as intermediate slope drain pipe, and the upper drainage ditches discussed above are connected to the lower drainage ditches by a series of connecting ditches referred to as downslope flumes. The downslope flumes are similar to the lower drainage ditches in design, although additional riprap will be provided to dissipate the water's energy due to flowing down the steeper 20% grades [82].

Culverts. The construction of culverts will direct surface runoff for discharge from the lower drainage ditches to the sloughs (referred to as discharge culverts). Road culverts will allow discharge across the roads. The design discharge culvert's outlet will be above the 25-year flood level. The design discharge culvert is 40 feet of 30-inch corrugated culvert with 50 feet of riprap extending to the sloughs and the design road culvert is 15 feet of 20-inch corrugated culvert [83].

CONCEPTUAL STORMWATER QUALITY ELEMENTS

Overview. In addition to lined ditches and culverts, sediment collection ponds will be provided to retain sediment generated from the cap, especially during the construction phase. These proposed ponds, will assure the turbidity of surface runoff is lower than that of the sloughs[84]. The ponds would be decommissioned after the cap is completed if sediment transport is determined to be negligible .

The Design Sedimentation Pond. The design pond is approximately 100 x 60 x 6 feet deep, based on criteria presented in the surface water design manual published by King County, Washington. Because it will probably require excavation of solid waste for its construction, water collected in the ponds will occasionally be field monitored to evaluate the water quality and the presence of leachate [85]. For worker safety, direct contact with the pond water will be avoided when leachate is present. Furthermore, the pond's maximum design slopes (3H:1V) would allow safe exit in case of accidental entry [86].

Surface Water Runoff Measuring Flumes. Surface water runoff measuring flumes could be installed as part of a surface water monitoring program. Installation of 6 flumes should be able to measure almost the entire runoff from the landfill [87].

Stormwater Quality and the Construction Phase. The potential for the generation of degraded stormwater quality is greatest during the construction phase. As previously discussed turbidity can be controlled through the use of sedimentation ponds. Temporary sediment retention structures, such as silt fencing, can also be used. To assure that dissolved chemical species are not degrading water quality the following good practices and "housekeeping" will be carried out [88]:

1. Construction which requires exposing or excavating solid waste will be conducted during the dry season.

2. Excavated solid waste will be as promptly and properly relocated as possible.

3. Excavated solid waste not immediately relocated will be covered appropriately to eliminate rainfall infiltration.

4. In circumstances where leachate generation from exposed or excavated solid waste is unavoidable, the leachate will be collected and transferred to the site's leachate collection system.

Over the long-term, the potential for improving water quality in the sloughs by addition of stormwater runoff from the landfill is significant [89].

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D. Leachate Migration Control

SUMMARY

The term "leachate control" applies to the reduction of leachate generation and the minimization of leachate migration. Leachate generation control is primarily attained through the use of proper grading of good final cover materials and effective stormwater management, as previously discussed. This section is concerned with the minimization of leachate migration [90].

This section discusses two options for leachate migration control and proposes option one.

OPTION 1

1. Construction of a rock drainage layer where leachate seeps occur in order to prevent surface exposure and potential contact with leachate. Leachate would continue to enter surface water surrounding much of the landfill [91]. Experiments would be conducted to determine if localized patching with clay would stop seeps.

2. Continued use of the existing leachate collection system in Subareas 4 and 5 [92].

OPTION 2

1. Construction of a partial perimeter leachate collection system where leachate seeps are a problem. The system would cover portions of the slough side of Subareas 1, 2, and 3. [93].

2. As in Option 1, continued use of the existing leachate collection system in Subareas 4 and 5 [94].

RATIONALE

OVERVIEW

Landfill leachate is generated when water comes in contact with the solid waste. The volume of leachate generated is directly related to the amount of water entering the solid waste. Leachate quality is primarily a function of the nature of the waste, the time of contact between the waste and the water, and the ratio of water quantity to waste quantity. Leachate releases to ground and surface waters typically result in significant environmental impacts. Minimization or prevention of leachate generation and migration can be costly [95].

Leachate generation is dependent on the moisture content of the waste at the time of landfill closure, the amount of infiltration through the landfill cover system, and groundwater infiltration upward or laterally into the fill [96].

EXISTING LEACHATE MANAGEMENT

The current leachate generation at St. Johns Landfill can be described by separating the landfill into the following types of areas:

1. Areas with interim final cover (18 inches of clay covered with yard debris compost).

2. Areas with final cover (18 inches of clay covered with 6 inches of topsoil).

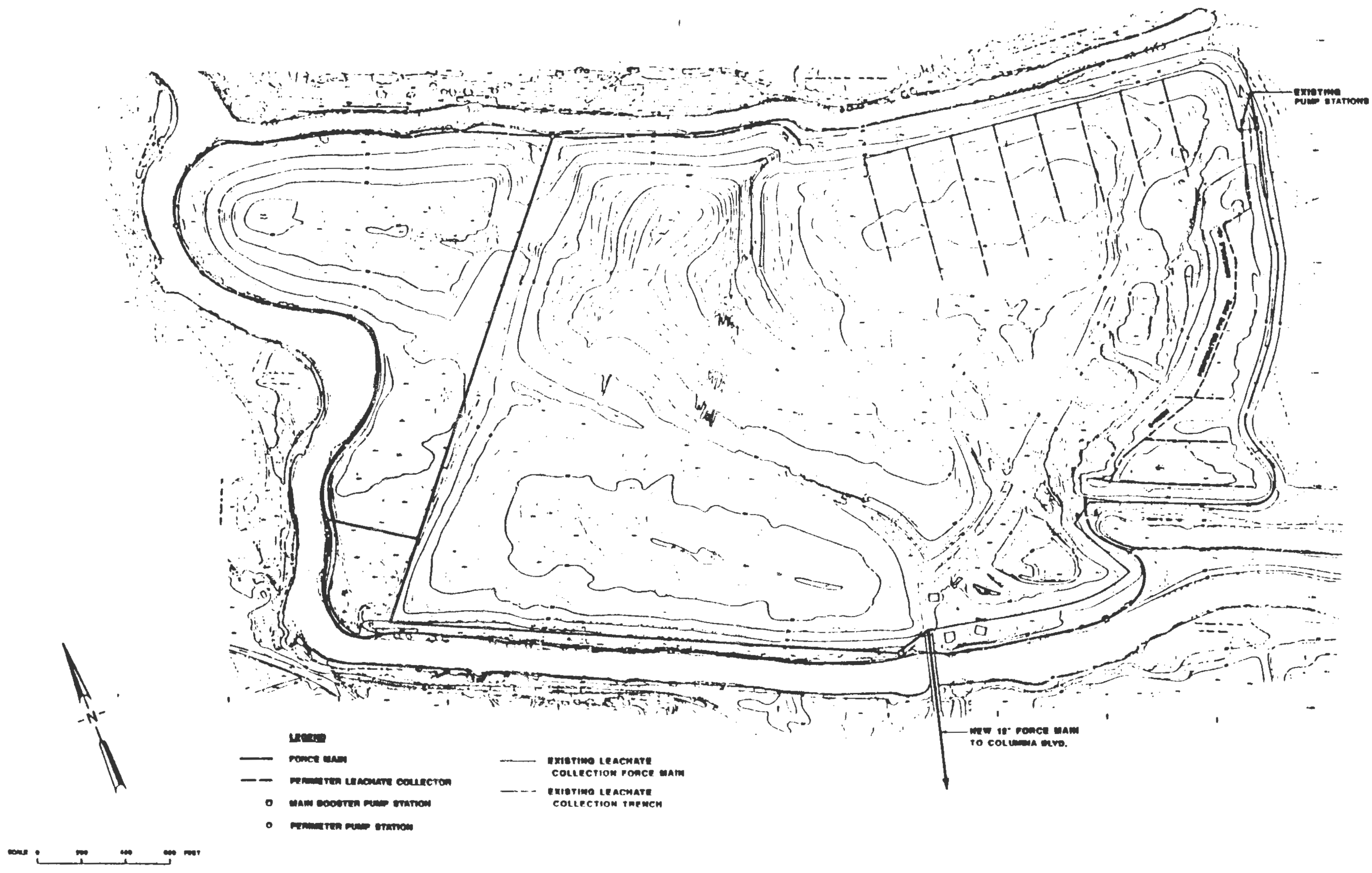
3. Areas with current fill operations and temporary cover (6 inches daily cover).

4. Areas without waste fill.

Areas with either interim final cover or final cover include Subareas 1, 2, 3, portions of 4, and the Powerline Corridor. Areas with current fill operations and temporary cover are in Subareas 4 and 5 [97]. A portion of Subarea 5 has yet to receive waste material. This area was approximately 10 acres as of early November 1988, and is located in the southeast corner of the landfill.

Existing Leachate Collection System. The expansion area (portions of Subarea 4 and 5), constructed in 1980, includes a leachate collection system. An upper level system was installed approximately 5 feet above the floor of the fill area in the inside of the perimeter dike. Also, a second collection system consists of a series of leachate collection trenches across the floor of the landfill. This lower collection system is shown in Figure 5. A dilute combination of leachate, groundwater, and surface water is being collected by the lower collection system and pumped to the City of Portland's Columbia Boulevard Wastewater Treatment plant to be treated. The City of Portland charges Metro for receiving and treating the leachate which current water quality tests show, for rate purposes, to be a dilute waste of standard strength. When the landfill is closed, the leachate strength is expected to rise while the quantity decreases due to the exclusion of most of the surface water from the landfill [98].

Lateral Migration. Lateral migration of the mounded leachate is evidenced by surface seeps at various locations along Columbia Slough and North Slough, especially visible during low slough water levels [99]. Although less visible, winter time rainfall results in a rising leachate mound leading to a higher seep flow rate [100]. The perimeter surface seepage discharges are estimated to be roughly 3% of total generated leachate during the dry season [101]. The 1988 Sweet-Edwards/EMCON hydrogeologic study indicated that the leachate seeps had no significant impact on slough water quality [102].



METRO *St. Johns Landfill Leachate Collection Systems* Figure 5

Location of Lateral Migration Nuisance Seeps. The surface seeps produced by the lateral migration are limited to the exterior perimeter of the older landfill site (Subareas 1, 2, and 3) and some seeps along the base of the internal slopes of the subareas [103]. The seeps are mostly concentrated in areas of the perimeter that appear on historic aerial photography to have been breaks in the naturally occurring berm next to the sloughs. The breaks may have been filled with more permeable material, such as sand, and therefore allow the leachate a preferential flow path to the surface [104]. However, it appears as if leachate is also slowly flowing through a fairly continuous natural berm of silt along the south side of Subarea 2 (above the slough and, in limited areas, above the perimeter road) [105].

Downward Migration. Downward migration of leachate exists as shown by the hydraulic gradient through the underlying alluvial deposits. These deposits slow down or stop the migration of many of the contaminants in leachate. Low levels of offsite degradation due to landfill operations were indicated by the 1988 Sweet-Edwards/EMCON hydrogeologic study [106]. In Subareas 1, 2, and 3, upward infiltration through the bottom of the fill is currently limited by the downward hydraulic pressure of the leachate mound and the fact that the solid waste is not far below the water table [107].

Leachate Characteristics. Sweet-Edwards/EMCON was able to sample leachate seeps in six locations along the North Slough and Columbia Slough from August through November 1988 [108]. The analysis indicated a moderately dilute leachate compared to typical leachate quality. Additional field work will be necessary to further characterize the leachate prior to final design of collection and treatment facilities. The strength of the leachate determines: (1) whether it must have pretreatment prior to discharge to the City wastewater system and (2) how much the City's utility charges for treatment will be [109].

Leachate Movement and Elevation of the Leachate Mound. As stated in Section B (Final Cover) past records show the leachate mound in Subareas 1, 2, and 3 has remained at a fairly constant level over the past 15 years. It is expected that the leachate mound will decrease as leachate migrates downward through the underlying fine-grained alluvial deposits and laterally through the berm and dike areas after final cover placement. With a geomembrane cap, Sweet-Edwards/EMCON estimates a decrease in the average leachate mound height of approximately 6 feet in the first 16 months going down to the elevation of area ground water (5 ft. MSL) in about 7 years [110].

In-Waste Leachate Head Reduction with Vertical Wells or Horizontal Drains. The use of in-waste leachate head reduction, with either vertical wells or horizontal drains to decrease the rate and quantity of leachate moving from the landfill to the underlying aquifers, was studied. Although it would be most desirable to reduce the leachate mound to a 1-foot thickness or less, such as the DEQ requirement for active landfills with liners, it may not be attainable throughout the St. Johns Landfill due to the sloughs and other variable subgrade conditions, spatial variation of permeability in the refuse, and leachate locally perched within the solid waste [111].

The Effectiveness of Vertical Wells or Horizontal Drains. Sweet-Edwards/EMCON, Inc. has also had experience with both vertical wells and horizontal drains at the Cedar Hills Regional Landfill in King County, Washington. It applied this experience to St. Johns Landfill to estimate leachate head reduction time lines with vertical wells or horizontal drains at total pumping rates of 5 and 10 gallons per minute. Comparison of the timeliness indicate that 5 and 10 gallons per minute pumping rates would increase leachate removal 2% and 4% respectively over unaided drainage. In summary, neither the completed vertical wells ($25,000/well, 0.5-1 gpm) nor the horizontal drain ($100,000/700' drain, 0.1-1.5 gpm) appears to be cost-effective using current technology [112].

OPTION 1

This option provides protection from surface outbreak and physical contact with leachate, but does not itself reduce leachate migration to the surrounding surface waters. Instead, the control of leachate generation by grading, geomembrane cover system, and stormwater management would be relied upon to reduce leachate migration by lowering the leachate mound which drives leachate migration. A free-draining rock layer would be constructed at all leachate seep locations to provide a path for subsurface leachate drainage to the sloughs. Construction of these layers would not increase or decrease the leachate seepage rate but the low-cost system would protect the public from contact with the leachate. The existing leachate collection system in Subareas 4 and 5 would be utilized as planned [113].

Tests would be conducted to determine if there are areas of higher permeability soil in the levees around the older area of the landfill. These areas would be excavated and filled with a clay barrier. Experiments would be performed to determine whether localized patching of leachate seeps would effectively stop seepage as the internal leachate mound declines.

OPTION 2

Reduction of nuisance seeps at the highest leachate impact areas would be accomplished by constructing a partial perimeter leachate collection system to intercept part of the lateral flow [114], Figure 5 shows the location of such a system, as well as the existing system. The existing leachate collection system in Subareas 4 and 5 would be utilized [115], as in Option 1. The partial perimeter leachate collection system would consist of perforated collection pipes installed in ditches backfilled with drain rock. A dual system with one set of pipes higher than the other would be constructed so that it can be operated to match the seasonal variations in the slough water surface elevations. Using the pipe system above the surface water level in a given season would reduce the amount of slough water collected, and thereby reduce the volume of surface water pumped and treated with the leachate [116]. Before constructing the system tests would be conducted to determine if there are areas of higher permeability soil in the levees around the older area of the landfill. These areas would be excavated and filled with a clay barrier.
The leachate collector pipes would be connected to small pump stations at intervals along the perimeter. A pressure force main would deliver the leachate to a larger booster pump station that would pump the leachate from the perimeter leachate system and the existing expansion area leachate system to the City force main at Columbia Boulevard [117].

This system would have the advantage of reducing visible lateral leachate seepage in the high impact locations. However, some surface leachate seeps may continue and some contaminated groundwater from the landfill will still migrate under the perimeter collection system and seep into the sloughs. Also, some perimeter trees would be removed to accommodate construction, and construction would result in short-term releases of leachate to the environment due to the excavation of waste material [118].

Option 2 would also involve the cost of collecting and treating leachate and inward migrating surface water for the indefinite future. Because of this cost and because leachate generation control is expected to reduce outward leachate seepage in time, Option 2 is considered less cost-effective than Option 1.

E. Gas Control

SUMMARY

Landfill gas management prevents offsite migration, protects the surrounding and onsite human, animal, and plant life, and prevents damage to the final cover system [119].

ACTIVE GAS COLLECTION SYSTEM

1. An active gas collection system with periodic vertical gas collection wells and some collection trenches [120].

2. A network of either above- or below-ground collection headers would be used to transmit the gas from the wells [121].

3. A central blower would collect the gas and it would be burned in an enclosed flare [122].

RATIONALE

OVERVIEW

A significant by-product of the organic decomposition process at a landfill is the generation of gas. The gas is produced by the bacterial decomposition of organic refuse components in an oxygen-free (anaerobic) environment. Landfill gas production can begin within weeks after refuse placement and continue for 50 to 100 years, or more. Once begun, landfill gas production continues until all biodegradable organic material is decomposed [123].

Landfill Gas Characteristics. The principal components of landfill gas are carbon dioxide and methane produced in approximately equal proportions. Carbon dioxide can affect surface vegetation, act as a simple asphyxiant, or affect leachate quality. Methane gas, at concentrations of 5 to 15 percent by volume in air, is combustible and can explode if it accumulates in a confined area in the presence of an ignition source. Like carbon dioxide, methane is not highly toxic to humans, although it does act as a simple asphyxiant when accumulated in confined areas. Another adverse impact of landfill gas may be the presence of trace contaminants which may affect human health [124].

Pure methane gas is colorless, odorless, and lighter than air. It seeks the easiest path to vent itself to the atmosphere, and it can become trapped in unventilated structures, where it can be difficult to detect by human senses. Since the methane is usually present in concentrations above the upper-explosive-limit (UEL) in landfills, it eventually enters the combustion range of 5 to 15 percent as it migrates from the landfill and dilutes with air. In landfills capped with soil cover materials much of this dilution takes place within the soil, and the methane is usually below the lower-explosive-limit (LEL) of 5% by volume by the time it reaches the atmosphere. Any activity that makes the landfill cover less permeable will increase the tendency for lateral migration. The use of a geomembrane cap for landfill closure will prevent the landfill from venting the gas through its cover. In landfills capped with geomembrane covers, the methane must migrate horizontally until it reaches a means of escape [125]. Thus, a gas collection system is necessary to collect and remove the gas.

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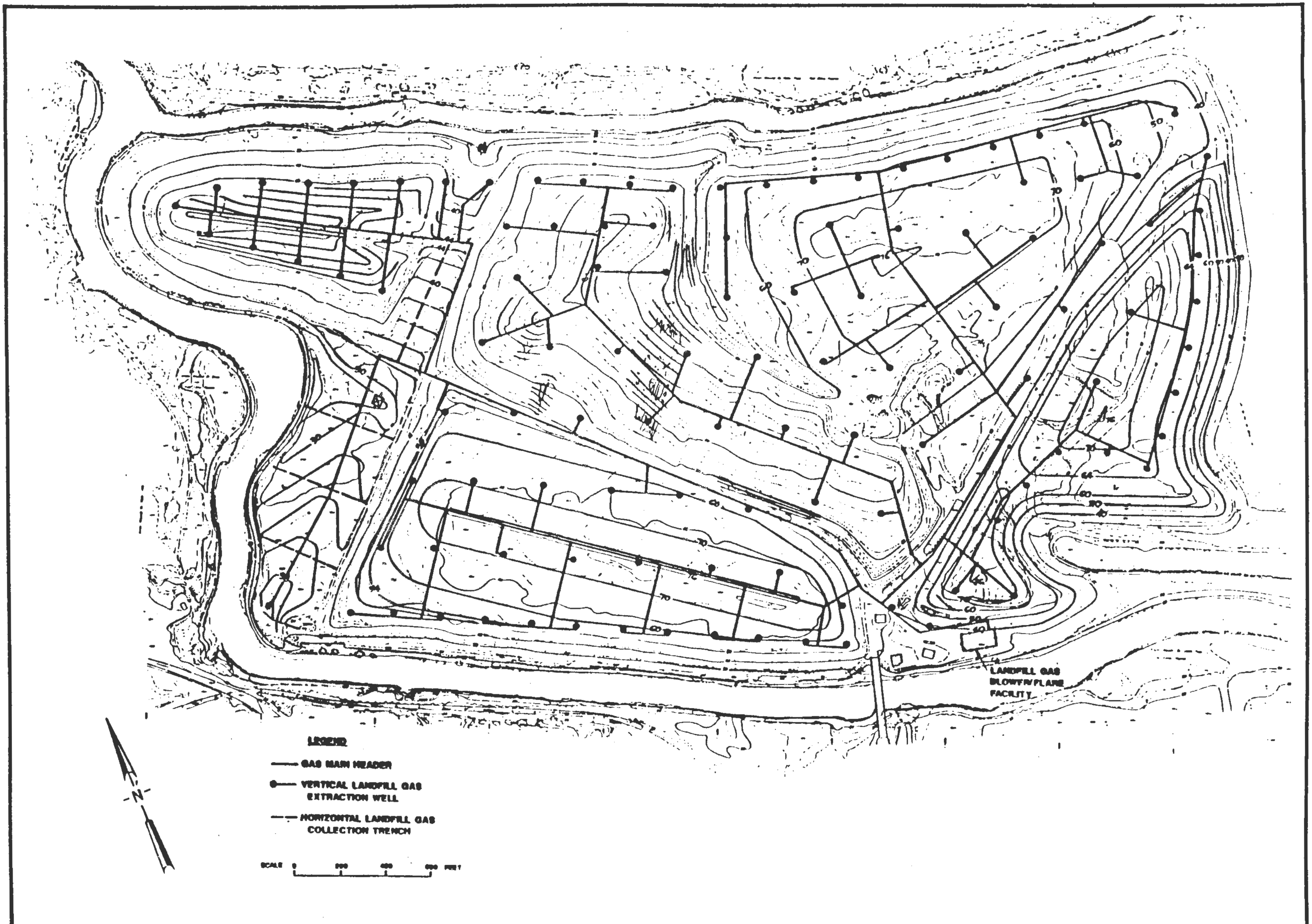
Active vs. Passive Gas Control System. Both active and passive gas control systems have vertical wells and/or horizontal trenches in the solid waste to collect the gas. A passive gas control system has ventilation pipes which extend upward through the cover. There can be a torch at the end of each pipe so that the gas can be burned. A passive system relies on internal gas pressure in the landfill to force gas out through these pipes.

An active gas control system costs more but is more effective. It also allows gas to be collected for energy recovery if this is economically feasible. An active gas collection extracts the gas within the waste using a negative pressure caused by a suction fan. The gas is carried from each well or trench through a network of pipes to one central point. There it is burned by an enclosed flare to minimize air pollution. Alternatively, energy can be recovered from it by various methods.

LANDFILL GAS AT ST. JOHNS LANDFILL

It is proposed that gas at St. Johns Landfill be controlled by the use of an active gas collection system [126]. A gas control system is necessary to remove gas which will accumulate under the plastic geomembrane component of the cover system. An active gas control system costs more to construct and operate but is more controllable, more efficient in removing gas, and makes it possible to also recover energy from the gas if cost effective.

This active system includes installation of vertical extraction wells over the landfill area, with limited use of horizontal collection wells, as described above, in the shallow and saturated refuse areas. All wells could be provided with adjustment valves and gas monitoring capabilities to provide individual throttling of well extraction rates as needed. The gas would be extracted from the landfill under a negative pressure provided by landfill gas blowers installed as part of a centralized equipment complex located near the site entrance. From the wells the gas would be transmitted through a network of either above- or below-ground collection headers to the equipment facility, where it would be flared using an enclosed ground flare [127]. Figure 6 shows the active gas control system. The cost estimate used for Financial Assurance assumes below ground collection headers. Since Subtitle D rules not yet been adopted by EPA, there is a degree of uncertainty concerning its impact on current landfill gas collection system design uncertainity concerning its impact on current landfill gas collection system design considerations [128].



METRO *St. Johns Landfill Gas Collection System* Figure 6

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Above-Ground vs. Below-Ground Collection Pipes. Above-ground pipes can be installed more cheaply than below-ground systems, and they are easier to maintain and repair. However, they are in direct view and they are potentially susceptible to vandalism. For both types of installations, above- or below-ground access to the adjustment valves and sampling ports is necessary for proper system operation. For above-ground systems, access is simple. For buried systems access can be achieved either by installing the adjustment valve and sampling port into flush-mounted concrete or polymer valve boxes, or installing the individual well adjustment valves and sampling ports above ground with the collection header entirely underground. In all cases, flexible couplings or pipe anchors would be installed to provide flexibility for not only settlement considerations,. but also for movement of the pipe during its thermal expansion and contraction [129]. The costs in the Financial Assurance Plan assume a below ground active gas control system without energy recovery.

An inclosed flare, consisting of a refractory-lined cylindrical shell surrounding a gas burner located at the base of the shell, burns the discharged gas - controlling odors and emissions. Typically, flares can range from 6 to 12 feet in diameter and as much as 40 feet in height. The height of the flare shell provides for a nonvisible flame while ensuring a sufficient residence time for efficient destruction of the gas [130]. It is understood that a DEQ Air Quality permit will be necessary before the flare can be operated.

PROS AND CONS OF PROPOSED ACTIVE GAS CONTROL SYSTEM

Advantages. The advantages of this proposed system are as follows [131]:

- It is environmentally considered state-of-the-art such that new regulations are unlikely to result in changes to the system.

- It is compatible with both soil and geomembrane caps for landfill closure; thus, it would be effective throughout the final cover installation period - assumed to take a number of seasons.

- It provides operational flexibility by being able to increase or decrease individual well extraction rates.

- Blower and flare controls can be fully automated to provide start-up and shutdown sequences, and remote alarm capabilities to notify operational personnel of system failures.

- The system design could be compatible for energy recovery considerations.

- The above-ground header system, if used, is less costly to install and easy to operate and maintain.

- The below-ground header system, if used, provides protection from vandalism and weather elements, and is compatible with landfill end-use and aesthetics.

Disadvantages. The disadvantages of this proposed system are as follows

- Additional costs to install, operate, and maintain (compared to passive gas control systems)

- The above-ground header system, if used, is susceptible to vandalism and weather

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damage, and is not compatible with landfill end-use development.

- The below-ground header system, if used, is more costly to construct, and operation and maintenance procedures are more difficult.

F. Environmental Monitoring and Site Security

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SUMMARY

1. Ground Water Levels and Quality. During Closure and for up to 30 years after closure 26 on and off site monitoring wells will be monitored for water levels and for the substances covered by the Post Closure Activities Chart.

2. Surface Water Levels and Quality. During closure and up to 30 years after closure seven slough or surface water stations will be monitored for substances to be determined in cooperation with the Department of Environmental Quality and the City of Portland's Columbia Slough Project. During this period five North Slough sediment stations and five surface run off stations will be monitored for substances covered in the Post Closure Activities Chart. Metro will cooperate with the City of Portland Columbia Slough Project in the construction of an automated water level and flow recorder at a mutually agreeable point in Columbia Slough.

3. Leachate levels in the landfill. Five new interior wells suitable for leachate monitoring will be constructed to penetrate to the bottom of the solid waste. Leachate levels will be accurately measured to monitor changes in the leachate mound elevation during the closure and post closure period. Measurement frequencies are shown in the Post Closure Activities Chart.

4. Quality of leachate discharged to the treatment facility. Monitoring shall be as specified in the City of Portland's Industrial Waste Water Discharge Permit.

5. Gas flare exhaust. The gas flare exhaust will be monitored as specified by the Department of Environmental Quality Air Quality Permit.

6. Monitoring well abandonment. Metro will use appropriate methods to abandon certain monitoring wells which no longer yield reliable information and/or are themselves a source of environmental contamination.

7. Monitoring well heads, leachate pump station wet wells and controls, and gas control system well heads, controls, and flare will be designed and operated to minimize safety and vandalism risks.

8. During closure, public access will be controlled.

9. Metro will work with the City of Portland to address post closure site security when the City revises it's end use plan.

RATIONALE

Existing Conditions

Ground and surface water at the St. Johns Landfill have been monitored since the early 1970's. The current monitoring system is described in volume one and two of the Sweet-Edwards/EMCON, Inc. report titled "Water Quality Impact Investigation and Environmental Management Options."

Current site security is promoted by limiting access at the landfill bridge to authorized vehicles and by challenging unauthorized vehicle and persons. Twenty-four hour operation of the gatehouse and landfill also discourages unauthorized entry.

Analysis of the Proposed Plan

Monitoring. As various environmental protective features (geomembrane cover, greater than five percent slopes, etc.) in this closure plan are constructed, it will be important to monitor the reduction of the leachate mound within the landfill and the impact of these protective features on groundwater, surface water, and air quality. The closure and post closure monitoring plan described above (and in the Post Closure Activities Chart) is designed to provide a short term assessment of site closure activities and a long-term assessment of off-site impacts. The monitoring program is described in more detail in Volume 3, Environmental Management Options, Section 7.

Exact details of the monitoring program will be worked out in consultation with technical specialists from the Department of Environmental Quality, the City of Portland, and other interested parties. The objective will be to build a cooperative information gathering network which avoids duplication and yields the most useful information for all users at a reasonable cost.

Some of the older monitoring wells have been obliterated by past landfill filling activities. Other wells no longer yield reliable information and/or are themselves a conduit for leachate migration into the groundwater (see Sweet-Edwards/EMCON, Inc. report Volume 1, page 126). During the closure process Metro will abandon all of the B, C, and E series wells remaining on the site. Also, D8A and D7A would be abandoned. Finally, interior wells A2, B5, EPA-B, EPA-Q, and EPA-R will be abandoned as replacement leachate monitoring wells are constructed.

Site Security. It is important to prevent vandalism of monitoring wells, leachate pump station controls and wet wells, and active gas control system. It is also important to reduce safety risks due to unauthorized entry into potentially dangerous areas such as pump station control panels and wet wells and also enclosed vaults containing gas system control and piping. Finally, it is important to prevent motorized vehicles from disturbing the final cover structure.

Individual structures such as monitoring wells,pump stations, and gas collection system components will be designed to resist unauthorized entry and vandalism. For example, monitoring wells will have locked enclosures. Leachate pump stations will have locked control panels and covered wet wells. The gas flare and blowers will be enclosed by a fence to discourage unauthorized entry. Warning signs will also be posted.

It is not proposed to fence the site perimeter. Access via the landfill perimeter is discouraged by the sloughs and lakes. Also, a fence would interfere with animal movement, be costly, and not stop a person determined to enter the landfill.

A difficult site security issue is how accessible to the public the site should be. Making the site conveniently accessible, especially be motorized vehicles, increases risk of vandalism and damage to the cover, and also the safety risk of unauthorized entry into dangerous areas.

These risks would be minimized most effectively if the public was discouraged from going on the site especially during the years immediately after closure. One way to accomplish this would be permit only maintenance vehicles across the landfill bridge. However, this would directly conflict with the City's current end use plan.

A less effective method be to limit vehicular traffic to certain areas of the landfill. For example, a parking area might be constructed at the landfill end of the bridge to accommodate model airplane flyers and other users. Public vehicles might be limited to certain roads. The fences or vegetation barriers such as hedges or blackberry patches might be used to restrict motorized vehicles to the roads.

During the closure period public access will be controlled by limiting vehicle access at the landfill bridge and by challenging unauthorized vehicle and persons. Also, Metro will work with the City of Portland to balance site security needs with end use desires as the City revises it's end use plan.

G. Closure Time Schedule

According to the current agreement between Metro and the City of Portland, St. Johns Landfill is scheduled to stop receiving solid waste by February 1991.

As of July 1989, Subarea 5 (see Fig.1) is being filled with solid waste. Once this is filled to the initial grades in the current operations plan it would receive intermediate cover.

Subarea 4 would then be refilled with solid waste using methods similar to the 1987-1988 refilling of Subarea 2. The initial contours would conform to the drawing titled Subarea 4 "Alternate #2 - Final Grading" in Sweet-Edwards/EMCON, Inc., Volume III, Environmental Management Options, Appendix B.

After Subarea 4 is filled to the proper initial contours solid waste refilling would commence in Subarea 3. Cutting and filling with solid waste would be performed as necessary to achieve at least 5% initial slopes.
Finally, Subarea 5 would be refilled with solid waste to achieve minimum 5% slopes by the time solid waste disposal ceases per agreement between Metro and The city of Portland. Drawings showing the initial contours for Subarea 3 and 5 would be filed with DEQ prior to refilling these subareas.

A tentative time schedule for other construction activities is shown in the table titled, "St. Johns Landfill Closure Construction Schedule". Although it shows schedules for two options, only option one is proposed. Although there may be future changes in the sequencing of individual construction, closure is expected to be completed in 1995.

Upon closure of the site, Metro will provide a copy of the file detailing the use of the site to the Multnomah County records office as required by OAR 340-61-043.

H. Post Closure Care

It will be necessary to carry out certain activities during an extended period of time after closure of St. Johns Landfill to ensure the site continues to be well managed. The Post Closure Activities Chart presents a checklist of activities which are expected to be undertaken each year after closure. Future changes may be required to respond to actual conditions.

A thirty year post closure care period is assumed in the Post Closure Activities Chart and the cost estimates in the Financial Assurance Plan (Section III). This post closure care period was assumed even though OAR 340-61-028(6) directs DEQ to terminate closure permits after 10 years unless there is a need to protect against a significant risk to health, safety or the environment. The 30 year assumption is a prudent precaution and is in line with the minimum 30 year post closure care period in EPA rules proposed under authority of the Resource Conservation and Recovery Act, Subtitle D.

Costs for post closure care will be borne jointly by Metro and the City of Portland under the terms of the agreement by which Metro operates the St. Johns Landfill. The current agreement was signed in 1986. Metro and the City of Portland need to renegotiate this agreement due to significant changes related to closure which have occurred since that time. Metro and the City have begun to renegotiate this agreement.

ST. JOHNS LANDFILL
CLOSURE CONSTRUCTION SCHEDULE
(in thousands of dollars)

	1990		1991		1992		1993		1994		1995		
	SUB-AREA	COST	SUB-AREA	COST	SUB-AREA	COST	SUB-AREA	COST	SUB-AREA	COST	SUB-AREA	COST	TOTAL
CLOSURE OPTION 1													
Grading and Access Road	1	110	4	110	5	80	3	120	2	120			540
Gas Collection System	1	294	4	295	5	215	3	315	2	315			1434
Final Cover			1	4730	4	4730	5	3140	3	4950	2	4950	22,500
Stormwater Management			1	250	4	275	5	170	3	260	2	260	1215
Leachate Control			1	151					3	85	2	39	275
Active Gas System Equipment							1,4, 5,3	250	2	62			312
Ground Water Monitoring Wells		200											200
Total		604		5535		5300		3995		5792		5250	26,476
CLOSURE OPTION 2													
Grading and Access Road	1	110	4	110	5	80	3	120	2	120			540
Gas Collection System	1	294	4	295	5	215	3	315	2	315			1434
Final Cover			1	4730	4	4730	5	3140	3	4950	2	4950	22,500
Stormwater Management			1	250	4	275	5	170	3	260	2	260	1215
Leachate Control	1,2	2000	3	900									2900
Active Gas System Equipment								250		62			312
Ground Water Monitoring Wells		200											200
Total		2604		6285		5300		3995		5707		5210	29,101

TABLE 2 - POST-CLOSURE ACTIVITIES CHART

	FREQUENCY[1]	YRS AFTER CLOSURE
COVER INSPECTION [132]		
Walking the landfill for: . Excessive/localized settlement . Erosion rills on cover soil . Exposed geomembrane surfaces . Evidence of vegetative stress	Monthly	
ENVIRONMENTAL MONITORING		
Groundwater levels/quality[133]		
. Leachate indicator parameters (26 wells)	Semi-annually Annually	0-10 years 10-30 years
. Priority pollutants (6 wells)	Semi-annually Annually	0-3 years 3+ years
. Evaluation of monitoring results		10 years
. Static water level measurements	With every water quality sample	
Surface water levels/quality[134]		
. Monitoring of stormwater – sediment and turbidity	Monthly Quarterly Semi-annually	0-2 years 2-5 years 5-30 years
. Monitoring of stormwater – specific conductance	Monthly < Monthly	0-2 years 2+ years
. Monitoring slough surface water-alkalinity testing parameters	Quarterly	0-30 years
. Monitoring North Slough sediment	Annually Biannually	0-10 years 10-30 years
LEACHATE/LANDFILL GAS SYSTEM MONITORING		
. Leachate levels in the landfill	Semi-annually Annually	0-10 years 10-30 years
. Leachate quality discharged to treatment facility	Cty. of Port. requirements	Cty. of Port. requirements
. Gas flare exhaust[2]	Annually	0-30 years

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[1] Semi-annually in April and October; Annually in April; quarterly in January, April, July and October.

[2] Frequency and parameters to be specified in the DEQ Air Quality Permit.

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I. Mitigation of Offsite Contamination

SUMMARY

1. Certain City of Portland and Port of Portland land north and northeast of St. Johns Landfill across Columbia and North Slough should be a part of the site for regulatory, but not waste disposal, purposes. This land is underlain by groundwater which appears to contain contaminants from St. Johns Landfill. The Oregon Department of Environmental Quality specifies that the alternative solid waste management unit boundary be located in the above mentioned land.

2. Metro pays for the connection to City water of water users who currently rely, for drinking water, on wells reasonably at risk from groundwater contamination from St. Johns Landfill.

3. Metro is willing to explore financing options for cost effective methods which maintain Bybee Lake at a level which prevents groundwater contaminated by St. Johns Landfill from entering Bybee Lake.

4. Metro pays for cost effective methods which maintain the surface water quality of North Slough within currently measured ranges.

5. Metro provides sedimentation ponds and other structures as necessary to ensure that surface water from St. Johns Landfill will augment the flow of Columbia Slough with higher quality water than the range of water quality currently existing near the landfill.

RATIONALE

Existing Conditions

St. Johns Landfill is contaminating and surface water in the surrounding sloughs and appears to be contaminating groundwater across Columbia and north sloughs to the North and North-East (See I-Introduction). This contamination does not appear to pose a serious risk to public health, safety, or the environment.

Analysis of Proposed Plan

The City of Portland owns St. Johns Landfill and operated it for four decades until 1980. Metro has operated it since 1980. During this time the landfill may have contaminated groundwater under certain City of Portland and Port of Portland land north and northeast across Columbia and North Sloughs. Because of the risk of contamination of this groundwater by the landfill, it is proposed that an alternative waste management unit boundary be specified by DEQ. Both the State and Federal procedures for approving an alternative boundary require that information about the factors listed below be analyzed and taken into consideration.

1. The hydrogeological characteristics of the facility and surrounding land;

2. The volume and physical and chemical characteristics of the leachate;

3. The quantity, quality, and direction of flow of ground water;

4. The proximity and withdrawal rate of ground water users;

5. The availability of alternative drinking water supplies;

6. The existing quality of the groundwater, including other sources of contamination and their cumulative impacts on the groundwater; and

7. Public health, safety and welfare effects.

In addition, proposed Federal regulations require that the "practicable capability of the owner or operator" be taken into consideration and that any land included with the area defined by the alternative boundary be owned by the landfill owner or operator.

At the St. Johns landfill site, much of the necessary information for evaluating an alternative boundary proposal has been generated and is available for analysis and consideration. Based on a preliminary review of this information, it appears that there are several favorable factors for the establishment of an alternative boundary at the site. These factors are:

1. Detailed information is available on the hydrogeologic characteristics of the site area and on the volume and physical and chemical characteristics of the leachate in the landfill.

2. Groundwater and surface water quality does not appear to have been significantly degraded the landfill.

3. There are very few wells and only one consumptive use of ground water in the area, and public drinking water supplies are readily available.

4. There appears to be little existing or potential impact to the environment or public health, safety, and welfare.

5. There are numerous other existing and potential contaminant sources in the general area.

The issue of land ownership cannot be resolved until an alternative boundary location has been proposed. However, much of the property adjacent to the landfill is owned by parties (the City of Portland and Port of Portland) who have expressed interest in and support for a good landfill closure plan.

In addition to these factors, it is important to note that an alternative boundary at the St. Johns Landfill would allow some of the proposed end uses to be located off of the actual waste disposal area. This would result in a reduction in the anticipated conflicts between proposed end use activities and the environment protection facilities that will be constructed as part of the site closure program.

City water is available to the areas around the landfill. According to a beneficial use survey, nearly all drinking water users are connected to it [135]. Because of potential contamination from many sources, it is questionable whether the lower aquifer in this area is a dependable source of acceptable drinking water although its quality is sufficient for most other uses. A cost effective way to avoid risk to public health is to encourage all drinking water users to use City water. Metro will pay the cost of connecting to City water any drinking water users who could reasonably be expected to be effected at by St. Johns Landfill.

Another alternative would be to drill wells, pump out the ground water for an indefinite time and attempt to remove the dilute contaminants by treatment. Based on past experience this method would involve long, perhaps perpetual pumping and treatment [136].

The most cost effective way to mitigate the contamination of ground water, is to eliminate the source of high concentrations of contamination [138]. This will be accomplished by the leachate generation control discussed in the previous sections of this chapter.

As discussed in Chapter I, Introduction, and Chapter II - D, contaminated water from St. Johns landfill enters both Columbia and North Slough by way of contaminated groundwater recharging the surface streams and also by way of seeps visible along the banks. There is a risk that contaminated ground water will also seep into the surface water of Bybee Lake if the Lake drops below 10.5 to 11.5 mean sea level (MSL).

To avoid contamination of Bybee Lake it appears to be necessary to hold its level at 10.5 to 11.5 MSL. This protection method is not compatible with the current Smith and Bybee Lake Management Plan which envisions Bybee Lake as receiving water directly from Columbia Slough according to the tidal cycles and being allowed to drain nearly or completely dry during some parts of the year.

Rather than receiving water from Columbia Slough, which is currently contaminated itself, Bybee Lake might receive fresh water from wells drilled into non-contaminated groundwater under the lake [137]. However, more dialogue is necessary among technical specialists and the various interested agencies and parties before a revised Bybee Lake Management Plan should be drawn up and implemented.

For several reasons the water quality in North Slough and Columbia Slough is expected to improve in the future. As discussed previously, the leachate generation control measures such as a geomembrane cap and storm water control with sedimentation ponds will reduce seepage of groundwater into the sloughs and augment flow in the sloughs with clean storm water from St. Johns Landfill. Also, efforts by the City of Portland to improve the quality of water in Columbia Slough will benefit both Columbia Slough and North Slough. Finally, any augmentation of Bybee Lake water or Smith Lake water from groundwater would discharge this water through North Slough and would augment its flow. This water would maintain or improve North slough water quality if this water were as clean as water in North Slough.

It is most cost effective for Metro to concentrate its mitigation efforts on North Slough. this stream is most directly impacted by the landfill, much more so than Columbia Slough which receives most of its contaminant load from sources other than the landfill. Metro's effort to mitigate impacts on Columbia Slough would be to provide sedimentation ponds and other structures as necessary to ensure that Columbia Slough would be augmented with higher quality surface water run off from the St. Johns Landfill.

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III. FINANCIAL ASSURANCE PLAN AND ORDINANCE

A. Cost of Closure and Post Closure Care

Closure and post closure care costs for two recommended options are presented in the Executive Summary in Volume 3 of the 1989 Sweet-Edwards/EMCON, Inc. report titled St. Johns Landfill Water Quality Impact Investigation and Environmental Management Options. The costs of both Option one and Option two are summarized in the following tables. A schedule showing the timing of construction costs is shown in the table entitled St. Johns Landfill Closure Construction Schedule in Chapter II, Section H.

Option One and Two are identical except for leachate migration control. Option One does not include a partial collection system around the landfill parameter. Thus, it costs less for both construction and long term post closure operation and maintenance.

Option One is proposed in this Revised Closure and Financial Assurance Plan. Costs for constructing and environmental improvements are estimated to be 26.7 million dollars under Option One. It is expected to cost 7.0 million dollars for operation and maintenance both during the five year closure period and for 30 years post closure. These costs are in 1989 dollars. Sweet-Edwards/EMCON, Inc. warrants them to be accurate to plus or minus 30 percent.

The 7.0 million total post closure care cost is currently borne by Metro and the City of Portland under the 1986 agreement by Metro which Metro operates St. Johns Landfill. It is anticipated that part of Metro's total post closure care cost costs will be paid from the St. Johns Reserve Fund described below with the remaining costs incorporated in the annual operating budget.

No costs are shown under Existing Contamination Mitigation. As noted in Footnote D it is assumed that off-site land acquisition costs are nominal. Also, there are no cost figures yet available for managing Bybee Lake to avoid entrance of leachate contaminated groundwater. It is expected that costs can be determined when a revised Smith and Bybee Lake Management Plan is produced by the City and the Port of Portland.

B. Form of Financial Assurance

The 1986 Closure and Financial Assurance Plan estimated that 5.8 million dollars would be needed for closure and post closure care. Since then it was concluded that substantially more money would be required for closure and post closure care.

Anticipating a shortfall in funds for closure and post closure care, Metro increased waste disposal rates by 150% beginning in November 1988. In part this was to "ramp" up to expected transportation and disposal costs for the Arlington Landfill as well as to provide for final closure and post closure care of St. Johns Landfill. During the Fiscal Year 1988-89 Budget process, Metro earmarked $10.4 for transfer to the St. Johns Reserve Fund. The approved Fiscal Year 1989-90 Solid Waste Budget earmarks another $12.0 million for contribution to this Reserve Fund. Metro anticipates contributing another $3.0 million to this fund in Fiscal Year 1990-91. These three contributions combined with previous collections including interest are estimated to give the St. Johns Reserve Fund about $31.4 million which is above the defined cost identified in the Sweet-Edwards/EMCON, Inc. report and listed under option one in this closure plan.

The current target of $31.4 million in the St. Johns Reserve Fund represents $26.5 million construction costs, plus $4.9 million for long term operation and maintenance costs and contingency. This total is expected to be accumulated in the St. Johns Reserve Fund by June 30, 1991.

Ordinance No. 89-300 dedicates the St. Johns Reserve Fund for the purpose of meeting the financial assurance requirements of Oregon Administrative Rule (OAR) 340-61-034. The St. Johns Reserve Fund would be a closure trust fund as allowed by OAR 340-61-034 (3)(c)(A). Ordinance No. 89-300 presents the current schedule for accumulating funds for St. Johns Landfill closure, post closure care and environmental impact mitigation. It allows the schedule to be amended in the future to reflect any revisions in the closure cost estimates that may be shown necessary by further analysis. Finally in compliance with OAR 340-61-034, it specifies that disposal of any excess money provide for rate reduction or enhancement of solid waste disposal facilities within the area from which the excess monies are received.

TABLE 3 - COSTS - OPTION NO. 1
ST. JOHNS LANDFILL CLOSURE AND POST CLOSURE MAINTENANCE
Millions of Dollars[f]

CLOSURE ELEMENT	CHOICE	TOTAL CONSTRUCTION COST	TOTAL 35 YR. O & M COST	TOTAL METRO O & M COST	TOTAL CITY O & M COST
LEACHATE GENERATION CONTROL					
Cover	Alt. 4, Geomembrane, Entire site	22.5	0.66	0.13[B]	0.53
Grading/ Roads	Alt. 2, Fill to 88ft. MSL	0.54	included in cover cost		
Stormwater Management	Sedimentation ponds, Alt. 2	1.22	0.29	0.07[C]	0.22[C]
LEACHATE MIGRATION CONTROL					
	Expansion area system & Alt. 1, Cover seeps with rock, soil +Subarea 5 Collection system geotextile	0.28	0.21	0.12	0.09
GAS	Alt. 3, Active Collection[C]	1.95	1.03	0.09[A]	0.94
MONITORING	Ground-water Surface-water	0.2	4.8	1.1[C]	3.7[C]
EXISTING CONTAMINATION MITIGATION					
	City acquires Port land adjacent to landfill and develops certain end uses. Metro pays for city water connections for affected drinking water wells.	[D,E]	[D,E]	0.00	[D,E]
TOTAL COST (rounded)		26.7	7.0	1.5	5.5

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NOTES

[A] Metro O & M Cost assumes O & M until 1995.

[B] Metro O & M Cost based on six years O & M after closure in 1995.

[C] Assumes Total cost prorated on acreage basis (55 acres/238 acres) is Metro's share.

[D] Assume land acquisition costs are nominal. City is allowed to use Metro end use fund for off site land development. These costs not included in this analysis. For drinking water wells assume two wells connected to city water at fifteen thousand dollars per well.

[E] Does not include holding Bybee Lake at minimum level (if necessary) to avoid contaminated groundwater intrusion and enhancing flushing of North Slough. Augmentation of Bybee Lake with long term pumping would add pump cost and long term O & M Costs.

[F] Plus or minus 30 percent. All costs in 1989 dollars.

[G] Assumes below ground active gas collection system. If above ground system were chosen, construction cost would be 1.75 million; thirty-five year operation and maintenance cost would be approximately 0.87 million.

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TABLE 4 - COSTS - OPTION NO. 2
ST. JOHNS LANDFILL CLOSURE AND POST CLOSURE MAINTENANCE
Millions of Dollars[F]

CLOSURE ELEMENT	CHOICE	TOTAL CONSTRUCTION COST	TOTAL 35 YR. O & M COST	TOTAL METRO O & M COST	TOTAL CITY O & M COST
LEACHATE GENERATION CONTROL					
Cover	Alt. 4, Geomembrane, Entire site	22.5	0.66	0.13[B]	0.53
Grading/ Roads	Alt. 2, Fill to 88ft. MSL	0.54	included in cover cost		
Stormwater Management	Sedimentation ponds, Alt. 2	1.22	0.29	0.07[C]	0.22[C]
LEACHATE MIGRATION CONTROL					
	Expansion area system & Alt. 2, partial collection in areas 1, 2, and 3 +Subarea 5 Collection system geotextile	2.9	2.1	0.2	1.9
GAS	Alt. 3, Active Collection[C]	1.95	1.03	0.09[A]	0.94
MONITORING	Groundwater Surface water	0.2	4.8	1.1[C]	3.7[C]
EXISTING CONTAMINATION MITIGATION					
	City acquires Port land adjacent to landfill and develops certain end uses. Metro pays for city water connections for affected drinking water wells.	[D,E]	[D,E]	0.00	[D,E]
TOTAL COST (rounded)		29.3	8.9	1.6	7.3

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BEFORE THE COUNCIL OF THE
METROPOLITAN SERVICE DISTRICT

FOR THE PURPOSE OF DEDICATING THE ST. JOHNS RESERVE FUND FOR THE PURPOSES ESTABLISHED BY OAR 340-61-034	)))	Ordinance No. 89-300 Introduced by Rena Cusma, Executive Officer

WHEREAS, Ordinance 83-159 created a Reserve Fund for the purpose of receiving and monitoring monies earmarked for the post closure maintenance of St. Johns Landfill; and

WHEREAS, The amounts shown in Exhibit A have been appropriated to this fund through FY 1990; and

WHEREAS, The 1989 Revised Closure and Financial Assurance Plan shows the need for a reserve of 31.4 million dollars for closure, post closure care, and contingency; and

WHEREAS, A form of financial assurance acceptable to the Oregon Department of Environmental Quality is required by Oregon Administrative Rule 340-61-034; now, therefore,

THE COUNCIL OF THE METROPOLITAN SERVICE DISTRICT HEREBY ORDAINS:

1. Ordinance 83-159 is hereby amended to provide that the St. Johns Reserve Fund shall have the purpose of receiving and monitoring monies earmarked for the closure and post closure care of St. Johns Landfill and the mitigation of any environmental impacts of the landfill.

2. Monies for the Reserve Fund shall come from solid waste rates. The maximum sum in the account shall be provided and accumulated according to the schedule shown in Exhibit A, <u>St. Johns Landfill Reserve Fund, Contribution Analysis</u> subject to appropriation through the Metropolitan Service District's budget process.

3. To the extent that revisions in the closure cost estimates show that additional funds are needed, the Council will be requested to commit additional funds.

4. Any excess monies received or interest earned shall, with the approval of this Council, be used for a reduction of solid waste rates, a reduction of rate increases, or for the enhancement of past, present or future solid waste disposal facilities within the area from which the excess monies are received.

ADOPTED by the Council of the Metropolitan Service District this _______________ day of ________________________, 1989.

____
Mike Ragsdale, Presiding Officer

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EXHIBIT A

ST. JOHNS LANDFILL RESERVE FUND
Contribution Analysis

30-Jun-89
10:19 AM

Methodology:
Using actual tonnage going into the landfill, and the estimated cost provided by Sweet-Edwards/EMCON, Inc. to close the landfill, a rate per ton may be derived that will guide the level of Solid Waste Operating Fund contributions (transfers).
Actual tonnage used are to be waste figures over the life of the landfill since Metro acquired it in October 1980.
The latest estimate, $30.0 to $32.0 million, is from an May 1989 consulting report titled St. Johns Landfill, Water Quality Impact Investigation and Environmental Management Options.

Actual tonnage into the St. Johns Landfill (by Fiscal Year, includes Commercial, Public, and Transfer tons):		Annual Dollar Contribution	YTD Dollar Contribution	Interest	YTD Interest	Total Annual Contribution	Total YTD Contribution	Total Annual Contribution @ $5.02/ton	Total YTD Contribution @ $5.02/ton
Oct - June 1981	193,771	$0	$0	$0	$0	$0	$0	$973,659	$973,659
July - June 1982	216,247	0	0	0	0	0	0	1,086,596	2,060,255
July - June 1983	356,619	0	0	0	0	0	0	1,791,937	3,852,192
July - June 1984	553,055	0	0	0	0	0	0	2,778,987	6,631,179
July - June 1985	561,077	548,955	548,955	29,501	29,501	578,456	578,456	2,819,296	9,450,474
July - June 1986	687,561	536,445	1,085,400	59,640	89,141	596,085	1,174,541	3,454,851	12,905,326
July - June 1987	654,950	374,042	1,459,442	87,780	176,921	461,822	1,636,363	3,290,988	16,196,314
July - June 1988	666,318	382,012	1,841,454	132,617	309,538	514,629	2,150,992	3,348,110	19,544,423
July - June 1989	668,833	10,429,010	12,270,464	469,234	778,772	10,898,244	13,049,236	3,360,747	22,905,170
July - June 1990	604,364	12,000,000	24,270,464	1,333,447	2,112,219	13,333,447	26,382,683	3,036,804	25,941,974
July - June 1991	264,387	3,000,000	27,270,464	2,056,788	4,169,007	5,056,788	31,439,471	1,328,490	27,270,464
	5,427,182	$27,270,464		$4,169,007		$31,439,471		$27,270,464	

$5.02 per ton

Annual effect of contributions vs. defined goal (exclusive of earned interest):

At end of FY 1988-89:	$22,905,170	Contribution that should already be in Reserve Fund
	(12,270,464)	Less estimated FY 1988-89 YTD Contribution
	($10,634,706)	Shortfall in YTD Contributions from 1980 to 1989
At end of FY 1989-90:	$25,941,974	Contribution that should already be in Reserve Fund
	(24,270,464)	Less estimated FY 1989-90 YTD Contribution
	($1,671,510)	Shortfall in YTD Contributions from 1980 to 1990
At end of FY 1990-91:	$27,270,464	Contribution that should already be in Reserve Fund
	(27,270,464)	Less estimated FY 1990-91 YTD Contribution
	($0)	Shortfall in YTD Contributions from 1980 to 1991

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APPENDIX A – End Use of St. Johns Landfill

The primary objective of landfill closure is to finish off the landfill structure so it best performs its protective function of reducing negative impacts on health, safety, and the environment. A secondary objective of closure is to prepare for the end use of the land after closure. In some cases these objectives are compatible; in other cases there is a conflict.

Differential settlement minimum slope requirements, explosive gas production, and compatibility with environmental protective features put practical limitations on end use for landfills at least in the decade or two immediately after closure. To overcome these limitations is technically difficult and requires significant extra cost for construction as well as long-term operation and maintenance. Thus, the end uses of most landfills have been limited to parks, open space, and golf courses, where there is a compatibility of objectives and extra costs are minimized [138].

In June 1977 the City of Portland adopted an end use plan for the St. Johns Landfill. This plan envisioned a low intensity recreation end use for the St. Johns Landfill [139]. The landfill would serve as a gateway to the Smith and Bybee Lake Wetlands area. The proposed end uses are shown in Figure 7.

Although there are conflicts between some elements of this end use plan and this closure plan, there is compatibility for the most part. The closure of Subarea 1 (Figure 1) appears to be compatible with the end use plan. For subareas 2, 3, 4, and 5. The slopes will be steeper than contemplated in the end use plan but this is not necessarily incompatible with a planned open space end use. The model airplane area, the archery range and the Lakes parking area (with a five percent slope) for the Smith and Bybee Lakes viewing area can be compatible with the environmental protective features. In fact the landfill contours have already been adjusted for the Lakes parking area and access road. This was done under a 1987 agreement with the City of Portland.

The main areas of incompatibility are the proposed boat launch ramp at the north edge of the site, the recreational vehicle area, and the risks of unrestricted public access. The recreational vehicle park and boat launch ramp and storage area were seen in the end use plan as sources of revenue for end use improvements. The proposed boat launch ramp is not compatible with the grading plan in the powerline corridor due to drainage and poor foundation conditions in the area [140]. The 25 percent and five percent slopes in the RV Park area (Subarea 5) are not compatible with the access and parking requirements of recreational vehicles [141].

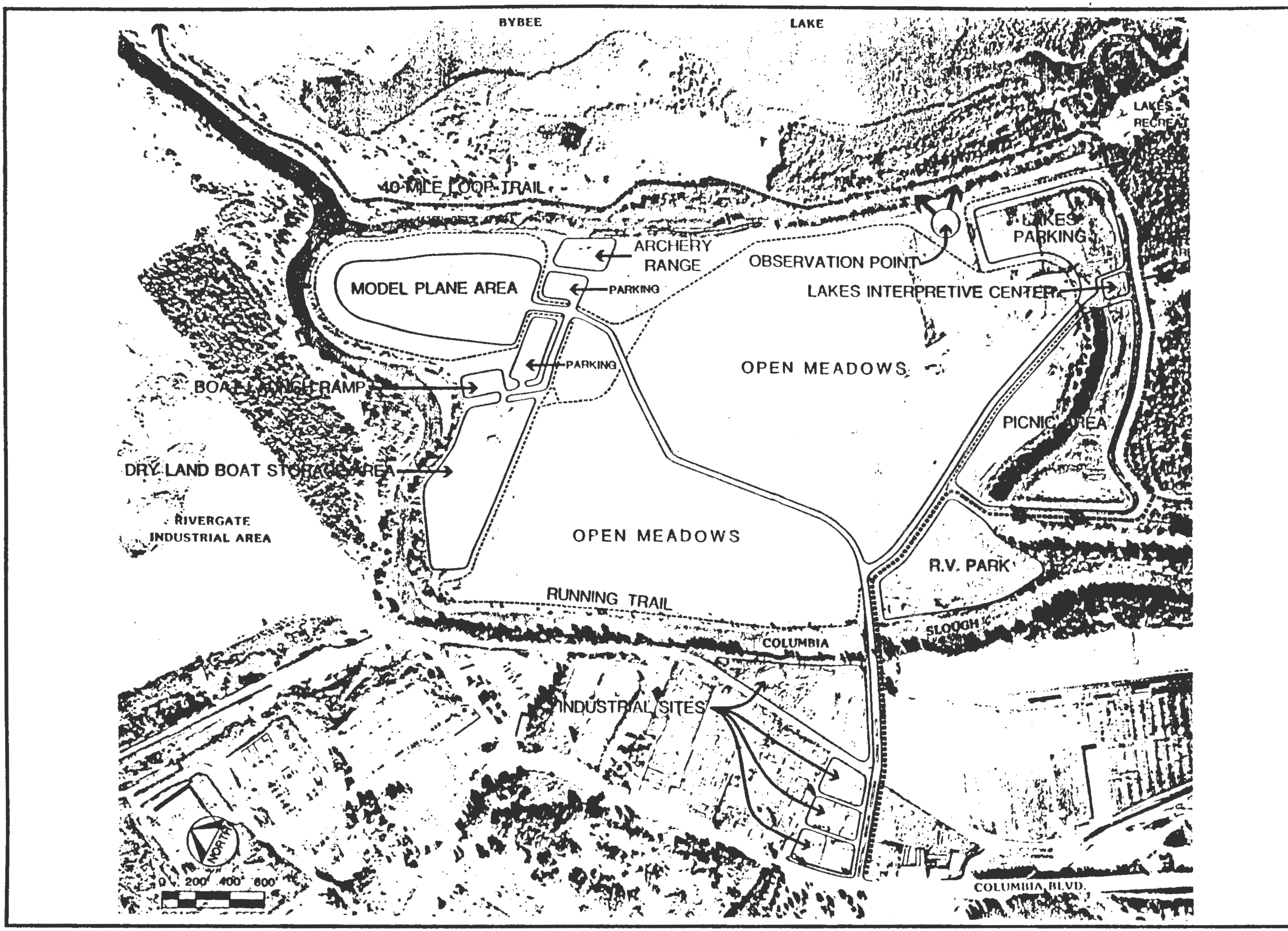
As stated in the monitoring and site security section of the closure plan, there are arguments for limiting public access to the landfill at least during the initial years after closure. Vehicles such as motorcycles and four-wheel drive vehicles could disrupt the protective function of the cover and the storm water system. The width and costs of the roads crossing the landfill would be greater for public use than for use limited to

maintenance and monitoring activities. Vandalism caused by unrestricted access could impair the protective function of the gas control and leachate control systems. There is a safety risk if there is unauthorized entry into certain areas.
Paying the extra cost of vehicle barriers, wider and stronger roads, and a buried gas control system would reduce but not eliminate the risks.

One solution would be to move some end use activities off site at least during the initial closure and post closure years. This would give the public some of the immediate recreational benefits of the end use plan while minimizing real and potential incompatibilities with the landfill's protective function. In the case of certain off site areas whose groundwater is apparently contaminated by the landfill (see mitigation section), off site end uses could come from long term control and responsibility for these areas by the landfill owner.

Some interested parties have suggested purchase and end use activity development on certain privately owned land between the landfill and North Portland Road south of Smith Lake. Also, suggestions have been made that money related to the landfill be made available for management of the Smith & Bybee Lakes wetland area. Also, there is some rational for use of landfill money for this purpose since the landfill potentially could impact Bybee Lake (see mitigation section).

The City of Portland has a solid waste fund. Part of this fund comes form Metro's lease payments since 1980. Also, since 1987 the City of Portland has been collecting 40 cents per ton of solid waste entering St. Johns Landfill. According to an agreement with Metro, this money is to be used for end uses on the Landfill. It is possible that, if requested by the City of Portland, Metro could allow some of this end use money to be used for off site land acquisition and development of end use activities in lieu of end use on the landfill. Consideration of the off site solution awaits City review of its current end use plan after approval of this closure plan by the Department of Environmental Quality.



METRO *St. Johns Landfill End Use Plan, City of Portland, 1987* Figure 7

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APPENDIX B – Closure as a Research and Recycling Opportunity

OBJECTIVES

1. Use St. Johns Landfill closure as an opportunity to test innovative landfill closure methods and materials on a small scale for later use.

2. Use St. Johns Landfill closure as an opportunity to recycle waste in an environmentally sound manner.

3. Use the St. Johns Landfill as a site for research which would benefit future landfill siting, design, operation, closure, end use, and regulation development.

SELECTION CRITERIA

A. Innovative/Experimental Methods or Materials

1. The method or material must be innovative - a different way of meeting a closure or post-closure need than those currently used.

2. Reasonable experimental evidence (bench scale test results or results of use for another purpose) must indicate that the material or method is of equal or greater cost-effectiveness than that currently used for landfill closure or post-closure care.

3. The scale of the test must be proportional to the reasonably estimated cost or benefit. For example, the test cost could be limited to one percent (1%) of the estimated cost or benefit.

4. The proposer and Metro share the cost of the test: The proposer bears the cost of providing the material or method; Metro bears the cost of testing the effectiveness and cost. The test may be eligible for funding under the One Percent Well Spent program if it includes innovative waste recycling.

B. Recycled Waste

1. Effectiveness (environmental protection benefit) of a recycled waste should not be significantly less than another recycled waste or a non-recycled material. The tests used to measure effectiveness could be according to item 2,3 and 4 above.

2. Recycled waste use should not pose a significant risk to health, safety, or the environment.

3. The total cost of using the recycled waste for closure or post-closure care shall be comparable to the cost of a non-recycled material or another recycled waste.

4. The vendor of the recycled waste should warrant the waste (for example, agreement to hold Metro harmless or a bond).

5. DEQ and City of Portland approval.

C. General Research

1. Metro will review research proposals on a case by case basis.

2. Financial support for research projects will be the responsibility of the proposers unless the project clearly advance Metro's solid waste management objectives.

PROCEDURE

Fall and Winter-1989-90

Solicit proposals for innovative materials or methods and for recycled wastes after DEQ approval of the closure plan and during final design and specification preparation.

Evaluate proposals. Select test projects and recycled wastes. Obtain City of Portland and DEQ approval as appropriate. Specify selected recycled waste in construction contracts.

Construction Season 1990 And Later

Apply recycled wastes when appropriate; build and monitor test plots of innovative, experimental materials and methods.

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APPENDIX C – Glossary

Alluvial deposits - Clay, silt, sand, gravel, or similar material deposited by running water.

Anaerobic - Oxygen-free

Area of Influence - The area which is influenced by a well (withdrawal of water causes lowering of the water table or other water surface).

Asphyxiant - Something which kills or makes unconscious through want of adequate oxygen, presence of noxious agents, or other obstruction to normal breathing.

Berm - A horizontal ledge in an earth or cutting to ensure the stability of a steep slope.

Blowers - Provide the vacuum at the collection wells to extract the gas from the refuse and discharge it to the flare.

Corrosive - Gradual deterioration or destruction by chemical action. The action proceeds inward from the surface.

Culvert - A covered channel for carrying water below ground level.

Decomposition - The breakdown of complex material (refuse) into simpler substances (by biological means in a landfill).

Differential settlement - Uneven downward movement of the landfill surface due to biological decomposition and compression of the refuse.

Dike - A mound of earth to retain water (or leachate in the landfill).

Drain - A channel pipe or duct for conveying surface or subsoil water or gas.

Drainage nets - Fabric used in place of gravel and sand for drainage.

Extraction gas wells - Wells for removing landfill gas.

Flare - Consists of a refractory-lined cylindrical shell surrounding a gas burner located at the base of the shell, controls odors and emissions.

Flumes - An open channel to carry water or for measuring flows.

Geomembrane - A synthetic plastic cover material, such as HDPE, used as a barrier to rainwater and gas.

Geotextile - Fabric used to prevent topsoil from clogging the underlying drainage material and thus protect synthetic plastic cover (geomembrane) of the landfill.

HDPE - High density polyethylene.

Headers - Pipes which collect gas from other pipes.

Hydraulic gradient - The slope of the water surface.

Infiltration - Percolation (see below)

Leachate - Pollutants that leach through the refuse in the landfill.

Levee - An embankment confining a river; a dike

Migration - Movement

Mil - Millimeter.

Organic - Compounds of carbon.

Percolation - The movement of water or gas through pore spaces of soil.

Permeability - Capacity of soil (or refuse) to transmit water (or leachate).

Ponding - Standing water (on the surface of the landfill due to differential settlement).

PVC - Polyvinyl chloride plastic.

Runoff - Water from rain, snow, etc., which does not percolate into the ground or evaporate into the atmosphere.

Side slopes - Steeper slopes on the perimeter of the landfill subareas.

Static water level - The level of elevation to which the top of a column of water within the landfill would rise if afforded the opportunity to do so.

Surface water - Water on the surface (sloughs, rivers, lakes, etc.) as opposed to subsurface (groundwater).

Top slopes - Slopes in the middle of the landfill subareas and at higher elevations.

Riprap - Stones that protect the sides of a river (or flume) from scour.

Sediments - Material which settles in a liquid.

Sedimentation ponds - Ponds for the sinking of soil or mineral grains to the bottom of the water which contains them.

Well - A shaft or bore hole sunk in the ground to obtain water or gas.

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DRAFT

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DRAFT

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DRAFT

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