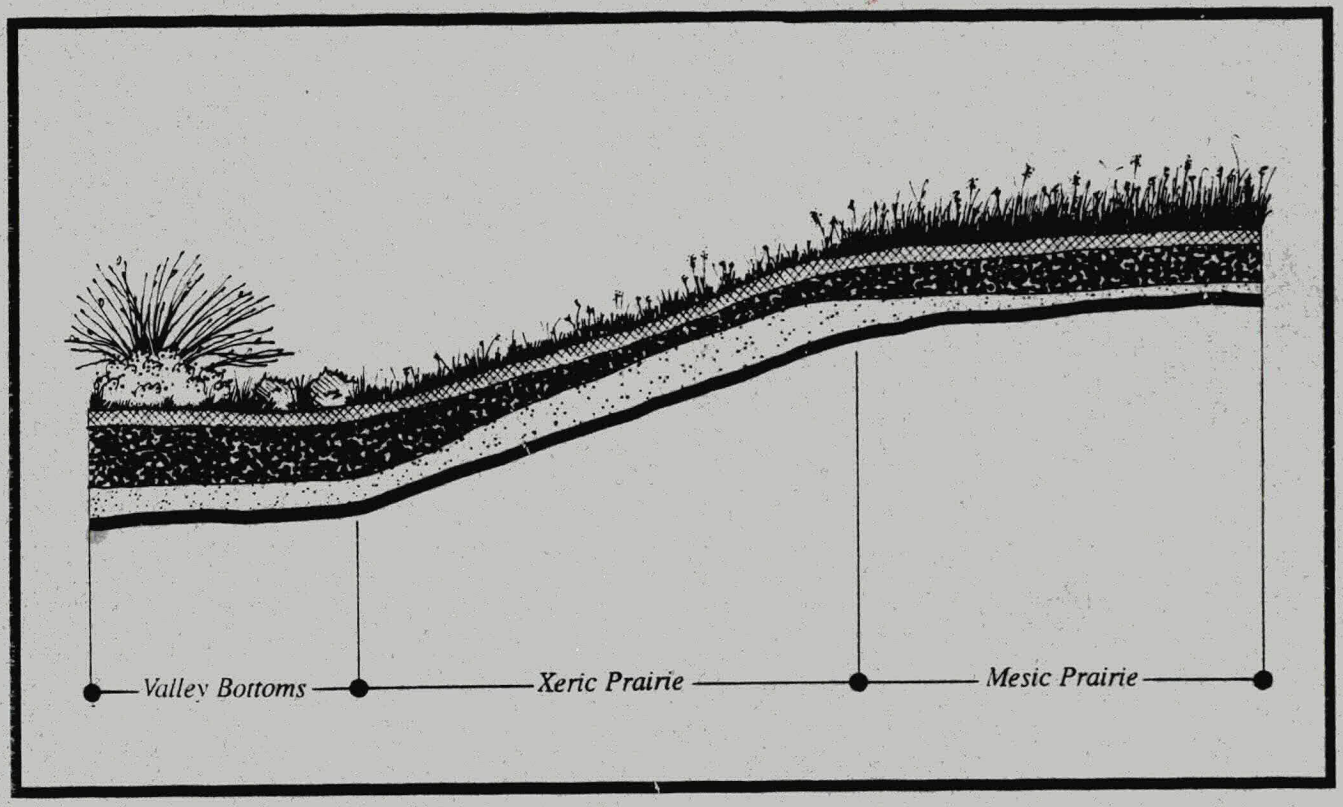
FISHMAN ENVIRONMENTAL SERVICES

Final Report

ST. JOHNS LANDFILL COVER VEGETATION PLAN



Submitted to:

Solid Waste Department
Metropolitan Service District

August, 1992

ABOUT THE FRONT DRAWING

The FES design team proposes that the catena approach to landscape establishment be adopted at the St. Johns Landfill. A catena is an association of soils related by landscape position (e.g., top, side, and bottom of slope) and, therefore, by drainage characteristics. In natural systems, hilltop soils can accumulate significant quantities of clays as they form naturally because they are not eroded away. Hill slopes are typically sandier textured because any clay that forms is susceptible to loss through erosional runoff. The base of slopes, where water energy diminishes, is a region in which the clay settles out and is concentrated.

The cover soil should vary with landscape position as it does in a natural catena, and with the anticipated vegetation to occupy the site. We will assume there are three general positions over the landscape:

1. the nearly flat ridgetops, for mesic prairie.
2. the slopes, occupied by the xeric prairie.
3. the valley bottoms, occupied by shrubs and understory vegetation, and either mesic or xeric prairie.

Jim Morgan

ST JOHNS LANDFILL

COVER VEGETATION PLAN

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FES NO. 453

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Landfill Cover Vegetation Plan was developed for closure of the St. Johns Landfill in Portland, Oregon. The Plan responds to specific design criteria established by the landfill closure manager, Metropolitan Service District (METRO) to conform with elements of the Landfill Closure Plan. These criteria addressed protection of the flexible membrane liner system, cost effectiveness, minimal maintenance, wildlife habitat enhancement, and aesthetics.

The Cover Vegetation Plan consultant team established policy, goals and objectives to guide Plan development; these were based on the METRO design criteria, and are summarized below:

Policy: The St. Johns Landfill Cover Vegetation Plan is composed of a complex of upland and wetland native plant communities. These communities will not jeopardize the integrity of the landfill cover system, and will provide habitat for a wide variety of plants and animals on a long term basis, mitigate for landfill impacts on water quality and habitat loss, and integrate ecologically and visually with adjacent natural areas.

Goals: The Plan design addresses goals established to: develop a complex of northwest Oregon natural plant communities along topographic and hydrologic gradients; specify soil constituents and structure that will result in a substrate with natural soil properties; visually and ecologically integrate the landfill into the regional ecological landscape; protect the integrity of the landfill membrane cover; evaluate the cost effectiveness of using native vs. non-native plants; and develop a monitoring program to document the effectiveness of the Plan.

Objectives: Numerous objectives were established to achieve the project goals. These objectives address: plant communities and wildlife on both the capped landfill surface and the un-capped riparian border surrounding the landfill; planting methods; soil composition and installation; ecological integration with surrounding areas; and experimental plots to test Plan elements.

The historical and landscape perspectives of the landfill are presented to establish the guiding focus of METRO for landfill closure. The regional importance of the landfill site is described within the context of the Columbia and Willamette River ecosystem, and its related flora and fauna. Opportunities to create and enhance wildlife habitat on the landfill site are discussed in relation to the proposed vegetation cover. The finished landfill cover is envisioned as a integrated component within the Smith and Bybee Lakes Natural Area.

The framework for the vegetation plan is an analysis of landfill slope aspects, drainage patterns and slope gradients. The analysis of these parameters resulted in identification of opportunities and constraints for vegetation community establishment. Three major vegetation communities were designed for installation on the site: mesic prairie for flat ridgetops, xeric prairie for side slopes, and shrub communities for the valley bottoms.

Each of the major plant communities is described by species. Additional descriptions are provided for bioswales, forested wetlands, and riparian woodlands along the landfill perimeter.

The Plan discusses and provides specifics for implementation and management for each plant community. This includes soil preparation, seeding or planting methods, acquisition of native plants, and the potential for growing plant materials on site, with recommended propagation methods.

Native and non-native vegetation is compared relative to installation costs, erosion control value, and ecological parameters. Maintenance costs over 30 years are also compared for native and non-native plants. These comparisons illustrate the advantages of using native vegetation for the landfill final cover.

A separate section of the report provides specifics for landfill Subarea 1 test plots. Experimental design is described in detail, including soil construction, planting methods, and sequencing of plan elements. The test plot design is based on implementation during 1992-93, and a monitoring plan is specified. A section is also provided on erosion control for the landfill closure; this section provides guidelines for erosion control planning and implementation.

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I. ST. JOHNS LANDFILL SITE DESIGN REPORT AND COVER VEGETATION PLAN

This Landfill Cover Vegetation Plan was developed for the Metropolitan Service District (METRO) for closure of the St. Johns Landfill in Portland, Oregon. Specific design criteria were established by METRO to protect the landfill membrane cover, and to conform with elements of the Landfill Closure Plan. These criteria were as follows:

1. Protects Cover System: Vegetation cover should minimize erosion and not threaten the integrity of the membrane cap. Plant roots in the landfill cover shall not interfere with drainage net functions including minimizing the risk of landslides of cover layers above the geomembrane. The root system of selected plants shall not allow perforation of the geomembrane nor provide habitat for borrowing animals that may endanger the integrity of the cover system.

2. Cost Effectiveness: Cost assessments should consider long-term maintenance as well as establishment cost.

3. Minimize Maintenance: A stable, diverse native plant community will likely require less maintenance than a grass monoculture and provide flexibility in meeting changing environmental conditions.

4. Habitat Enhancement: Increasing habitat values on the landfill (for non-borrowing animals) can provide food and habitat for indigenous wildlife for the adjacent lakes and wetlands.

5. Aesthetics: Scenic values can be enhanced on the landfill while reducing the need for fencing and screening.

Our team of consultants translated these criteria into the following policy, goals, and objectives.

1 COVER VEGETATION POLICY, GOALS, AND OBJECTIVES

1.1 POLICY

The St. Johns Landfill (SJL) Cover Vegetation Plan (Vegetation Plan) is composed of a complex of wetland and upland natural communities. These communities will not jeopardize the integrity of the landfill cover system; but they will provide habitat for a wide variety of plants and animals on a long term basis, mitigate for impacts on water quality and habitat loss, and integrate ecologically and visually with adjacent natural areas.

1.2 GOALS

THE VEGETATION PLAN IS DESIGNED TO ADDRESS THE FOLLOWING GOALS:

Design a complex of natural communities along a topographic and hydrologic gradient on and immediately adjacent to the capped landfill. These communities will be comprised of species representative of northwest Oregon natural communities.

Specify the proportions and management of soil constituents needed to develop a substrate with natural soil properties.

Integrate the site with nearby natural areas and insure no negative impact on such areas.

Develop a monitoring program to document the effectiveness of the Vegetation Plan.

Specify a vegetation cover system that will not jeopardize the integrity of the flexible membrane cover system or the cover slope stability.

Evaluate the cost-effectiveness of using native plant communities compared to exotics, in terms of installation and O&M costs.

1.3 OBJECTIVES

THE FOLLOWING OBJECTIVES WERE DEVELOPED TO MEET THE GOALS OF THE VEGETATION PLAN:

1. Plant Communities and Wildlife

a. Capped Landfill Areas

Plan/Design an open prairie with interspersed drainages planted to woody shrub hedgerows and wet prairie/sedge meadows.

Maximize habitat for shrub & grassland birds, insects and reptiles.

b. Riparian Buffer Areas

Plan/Design riparian woodlands and wetlands on lands adjacent to the Columbia Slough and Smith & Bybee Lakes. Use existing Columbia Slough area plant community inventory data.

Select woody and herbaceous plantings able to intercept and pretreat landfill leachate seeps.

Maximize habitat for riparian woodland edge wildlife species.

c. Plant Methods

Compare the costs and efficiency of the following methods of herbaceous and woody plant establishment: hydroseeding; modified brillion and/or range drilling; imprinting; and hand planting of plugs, in-situ hardwood cuttings and nursery container stock

2. Soil

a. Specify a silty clay loam soil substrate with specific chemical and physical parameters

3. Ecological Integration

a. Integrate SJL Vegetation Plan with Smith & Bybee Lakes Management Plan and planned regional recreation trails. Explore the possibility of an interpretive education trail on or adjacent to the landfill.

b. Establish a structurally and species diverse vegetation community of connected wetlands, riparian woodlands, upland shrubs/hedgerows, and grasslands.

c. Increase the width of the wildlife corridors adjacent to the waterways. Remove existing Road E.

4. Experimental Plots

a. Use experimental plot measurements to determine Vegetation Plan success. Experimental plots will examine species diversity, plant cover/density, soil properties, root growth patterns, soil and water losses, and turf stand health.

2 LANDSCAPE ECOLOGICAL OVERVIEW

2.1 SITE HISTORY

The earliest maps of the SJL site show it as a shallow pond or marsh surrounded by wetlands and slough channels. The pond was connected to a series of wetlands along the floodplain of the Columbia River that reached from the Sandy River to the Willamette. Lewis and Clark spent the night on the lower edge of the flood plain in November 1805 and hardly slept because the abundant waterfowl were so noisy. This demonstrates the historic value of the floodplain for resident and migrating waterfowl and shorebirds.

The SJL site habitat may have been similar to the adjacent Smith and Bybee Lakes; a shallow pond with abundant emergent vegetation surrounded by Columbia river willow, Pacific willow, Oregon ash, and scattered black cottonwood. Emergent species most likely included spikerush, bulrush, wapato, Columbia sedge, beggar's tick, rushes, and sedges. The slough channels most likely contained a well developed multi-layered riparian strip along their banks. The riparian vegetation was probably composed of bottomland hardwoods such as black cottonwood and Pacific willow in the canopy, with a shrub understory of ninebark, red elderberry, rose, creek dogwood, and black hawthorn.

The landfill site and the rest of the south bank of the Columbia flooded annually causing most early settlers to avoid inhabiting the area. In 1917 drainage districts began diking, pumping and filling the area, reducing natural drainage and transforming the flood plain. Remnants of historic habitats presently exist along the Columbia Slough and within the Smith and Bybee Lakes Management Area. Major disturbances, however, have significantly altered these landscapes; these include diking, filling, urban development, and introductions of exotic plants (i.e. reed canarygrass, Himalayan blackberry) and animals (i.e. European starling, carp).

In the 1930's the landfill began to receive Portland's garbage. The pond and adjacent wetlands were most likely drained and filled. The slough channel to the east was eventually cut off on the north end, becoming a series of ponds that were connected during high water in the winter. This remnant wetland was used by a nesting colony of tri-colored blackbirds until it was eventually filled in the early 1990's.

The SJL Vegetation Plan should address these historical habitat losses where possible. It may be impractical to create large wetlands, but wetland patches can be created in appropriate areas. Connectivity to other open space areas can be created and/or enhanced. The riparian corridor along the slough should be enhanced and enlarged wherever possible.

2.2 LANDSCAPE CONTEXT

St. John's Landfill is situated between two major rivers, the Columbia and the Willamette, and is adjacent to a stream corridor, the Columbia Slough, and a large wetland complex, Smith and Bybee Lakes. The landfill site is an island both visually and geographically. Columbia, North and Blind Sloughs form three sides of the site; Smith Lake is on the remaining side. The landfill's relationship to these major waterways and wetlands increases its wildlife habitat value, attracting a variety of resident and migrant wildlife.

The SJL site is in a significant location ecologically. Columbia Slough is a major wildlife corridor extending east from the Willamette River to Fairview Lake. The Smith and Bybee Lakes wetland complex is a regionally significant resource area. The integration of waterways, wetlands, riparian corridors and uplands is used by resident fish and wildlife as well as migratory species of fish in the Columbia-Willamette system, and wildlife using the Columbia-Willamette Rivers and Tualatin Mountains.

2.3 WILDLIFE HABITAT

Covering and revegetating the landfill provides an opportunity to enhance these riparian corridors and create uplands that provide additional food, cover, and nesting sites for wildlife. There are four basic habitats that will be created: prairie, wetland prairie/bioswale, shrub/forest. Each habitat benefits wildlife in unique ways and attracts wildlife species that are adapted to its features. The variety of habitat types further increases wildlife species richness by providing habitat for species that utilize more than one habitat type.

The prairie community is characterized by clumps of native grasses mixed with wildflowers. The flowers provide nectar for butterflies and other insects in spring and summer. The vegetative parts of grasses and flowers provide forage for invertebrates, and rabbits and other small mammals. The grasses and flowers provide a variety of seeds that ripen at different times throughout the late spring and summer. Seeds are significant food resources for sparrows, goldfinch, voles, and mice. The clumps of grasses and larger wildflowers provide nesting cover for ground nesting birds such as western meadowlark and savannah sparrows. They provide support for vole runways and tunnels and conceal reptiles such as racers and gartersnakes.

The wet prairie/bioswale communities are similar in structure to the prairie community except seasonal water is present. This benefits all wildlife that inhabit this community. It also attracts a greater number of species. The seasonal water provides breeding habitat for treefrogs and potentially better feeding areas for ground feeding birds such as the common snipe and the northern flicker that probe soils for invertebrates.

The shrub community consists of seed and berry-bearing bushes and small trees. Berries and seeds benefit a variety of bird and mammal species. The bushy structure of the shrub community provides nesting opportunities for numerous birds and important cover for all wildlife species. Common birds that nest and feed primarily in shrub habitat include rufous-sided towhee, Bewick's wren, song sparrow, house finch, American goldfinch, lesser goldfinch, and Brewer's blackbird. Deer browse on shrubs. Small mammals such as brush rabbit nest at the base of shrubs. Others, like mice, burrow beneath them.

The forested wetland/riparian woodland communities are the most significant wildlife habitats because they are associated with seasonal and year round water, respectively, and because they contain diverse vegetation and structure. Water attracts all wildlife species and is a limiting factor for the breeding cycle of many amphibians. The riparian woodland is a travel corridor for wildlife which use these corridors for dispersal and protective cover. The forested wetlands and riparian corridors contain similar structure for wildlife habitat. They provide a multi-layered canopy of diverse structure for nesting and roosting cover. Trees and shrubs provide seeds and berries for a variety of wildlife species. They also attract numerous insects and caterpillars which are a primary food source for gleaners such as warblers, kinglets, and chickadees. The Oregon ash, black cottonwood, red alder, and Pacific willow provide potential nesting areas for cavity nesters. Their wood is easily excavated by woodpeckers and used by many other wildlife species.

Many wildlife species utilize more than one habitat. They may use one habitat for nesting while using another for feeding. Ring-necked pheasant and California quail feed on fruits and seeds in meadows and hedge rows. Shrubs and tall grass clumps provide them with cover. Northern flicker nest in cavities in forests but feed on the ground in prairie habitat. Swallows will feed over prairies and nest in cavities in forests. American robin nest in the branches of trees and shrubs and feed in the open prairies. Great blue heron will hunt for mice in the prairies and swales and roost and nest in adjacent forests. Most mammals often utilize all habitats as they pass through all habitat types in their search for water and food. Mammals expected to occur include opossum, coast mole, coyote, red fox, raccoon, striped skunk, long-tailed weasel, black-tailed deer, pocket gopher, deer mouse, brush rabbit and eastern cottontail.

Predators are also common to more than one plant community. Red-tailed hawk and great-horned owl are the most common raptors in the vicinity. They will hunt from perches in the prairies and nest and perch in adjacent woodlands. If suitable nesting or perching habitat does not occur within or adjacent to the site, these species may not occur on site. American kestrel, nest in cavities in the forest, and prey on mice, grasshoppers, and small birds in the prairie. If suitable nest cavities are not present in adjacent woodlands or created on site, these small raptors also may not occur.

The quality of habitat created on the landfill can be enhanced by creating additional structures and preserving existing features. The prairie community which is generally low in structural diversity can be enhanced by creating additional structures like rock piles and small wood piles. These features could provide shelter and denning sites for weasels, rabbits, snakes and lizards which otherwise would not be present on the site due to the lack of structure. The forest community can be enhanced by preserving existing snags and/or dying trees, if present. Snags provide critical nesting habitat for cavity nesters; nest cavities are a limiting factor for many species. Nest boxes could also be installed to provide better nesting opportunities for desirable species.

3 VEGETATION PLAN OPPORTUNITIES AND CONSTRAINTS

3.1 REVIEW OF PROPOSED FINAL GRADING PLANS

The existing final grading plan for the entire SJL site and the proposed grading for the closure of Subarea 1 were analyzed and mapped to determine the opportunities and constraints for the establishment of a diverse natural vegetation. This mapping process was also used to identify areas of potential slope instability and erosion. The three criteria analyzed were: slope aspects, drainage patterns, and slope gradients; these are presented in the figures following this page.

3.1.1 Slope Aspect

The proposed grading plan for the landfill area was mapped in three categories: slopes generally facing north, slopes generally facing east, and slopes generally facing south and west.

The slope aspects were mapped for the purpose of differentiating microclimates which affect plant selection strategy. (See Figure)

3.1.2 Drainage Patterns

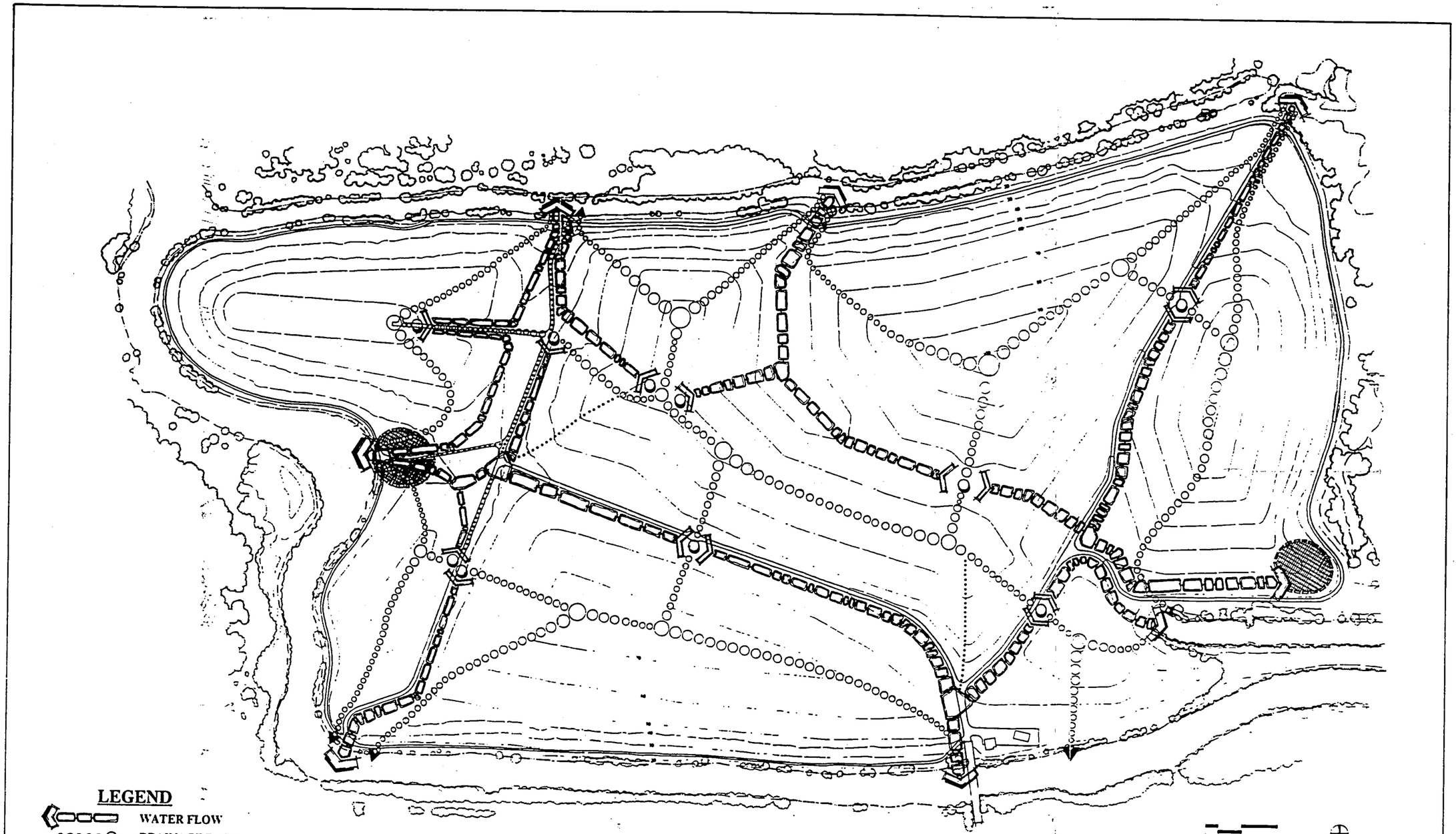
The proposed grading plan for the landfill area was mapped to determine overall drainage patterns on the site. Major runoff patterns, drainage subbasins and proposed detention facilities were mapped.

The purpose of this analysis was to differentiate potential hydrologic regimes in order to identify potential plant community locations. (See Figure)

We also propose removal of Road E in Subarea 1, and regrading of this perimeter terrace to slope slightly toward the bioswale.

3.1.3 Slope Gradients

The proposed grading plan for the landfill area was mapped by several categories of slope gradient. Slope gradients are a major criteria for determining slope stability, erosion potential, and runoff capability. (Refer to Rick Theil's memorandum located in the Appendix) (See Figure)



LEGEND

- WATER FLOW
- DRAINAGE BASIN
- SUB-BASIN
- FUTURE STORMWATER TREATMENT/DETENTION FACILITY

0 50 150 200
SCALE : 1" = 150'-0"
MAP SOURCE: -
DAVID C. SMITH & ASSOCIATES
PARAMETROL INC.

NORTH

DRAINAGE PATTERNS

METROPOLITAN SERVICE DISTRICT
SOLID WASTE DEPARTMENT

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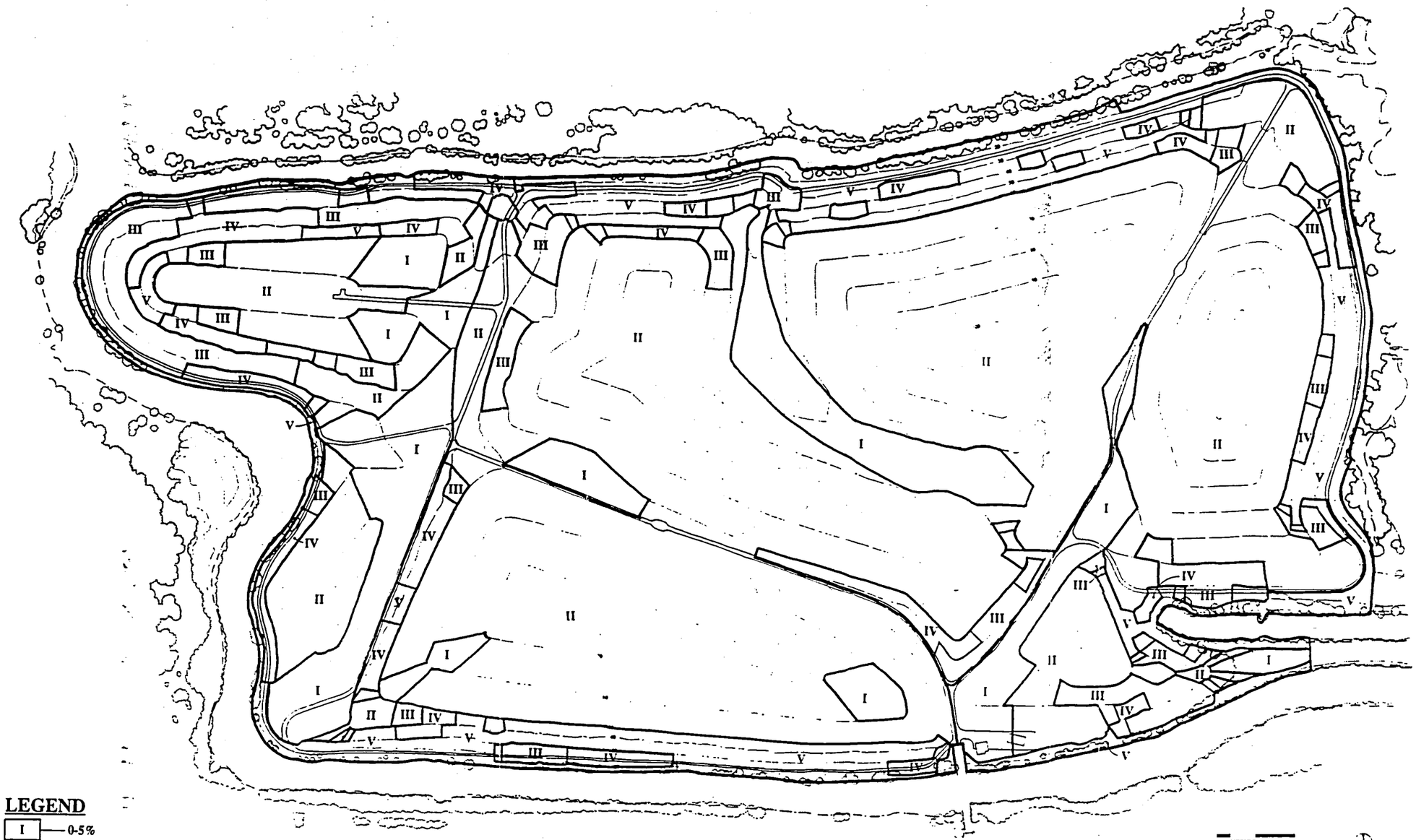
ST. JOHNS LANDFILL COVER VEGETATION PLAN



SLOPES

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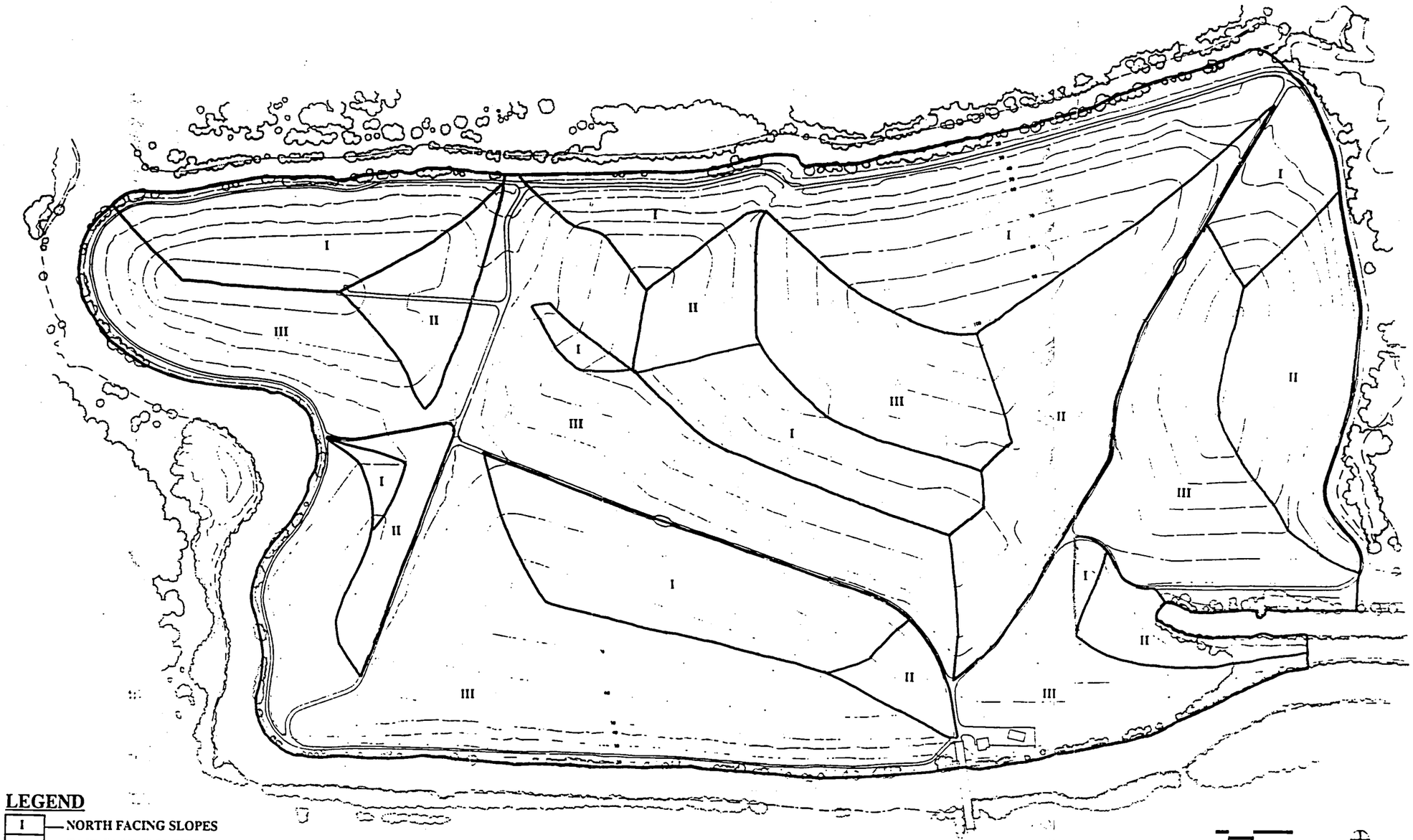
ST. JOHNS LANDFILL COVER VEGETATION PLAN



LEGEND

I	NORTH FACING SLOPES
II	EAST FACING SLOPES
III	SOUTH & WEST FACING SLOPES

0 50 150 300
SCALE : 1" = 150'-0"

MAP SOURCE:
DAVID C. SMITH & ASSOCIATES
PARAMETRIX, INC.

NORTH

SLOPE ASPECT

METROPOLITAN SERVICE DISTRICT
SOLID WASTE DEPARTMENT

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ST. JOHNS LANDFILL COVER VEGETATION PLAN

3.2 DESCRIPTION OF MANAGEMENT PLAN

The proposed site management plan was prepared to meet the cover vegetation policy, goals and objectives while responding to the constraints and opportunities that were presented by the analysis of the proposed final grading plans. The three preliminary maps (slope aspects, drainage patterns, and slope gradients) were overlayed to serve as a base for the development of the site management plan.

4 OVERVIEW AND GENERAL RECOMMENDATIONS FOR FINAL COVER SOIL

4.1 OVERVIEW

We will adopt the catena approach to landscape establishment (see Figure 1). A catena is an association of soils related by landscape position (e.g., top, side, and bottom of slope) and, therefore, by drainage characteristics. In natural systems, hilltop soils can accumulate significant quantities of clays as they form naturally because they are not eroded away. Hill slopes are typically sandier textured because any clay that forms is susceptible to loss through erosional runoff. The base of slopes, where water energy diminishes, is a region in which the clay settles out and is concentrated.

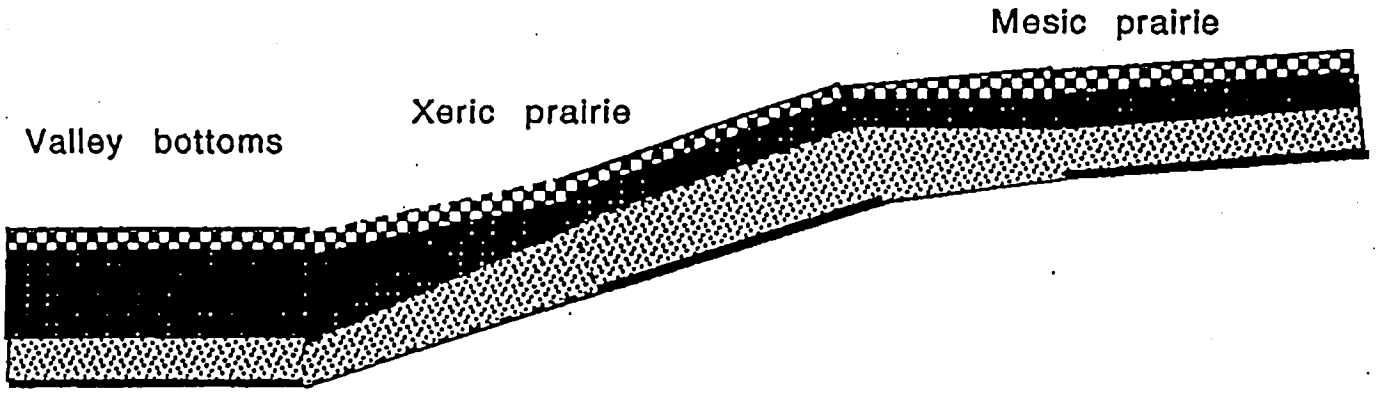
The cover soil should vary with landscape position as it does in a natural catena, and with the anticipated vegetation to occupy the site. We will assume there are three general positions over the landscape:

1. the nearly flat ridgetops, for mesic prairie.
2. the slopes, occupied by the xeric prairie.
3. the valley bottoms, occupied by shrubs and understory vegetation, either mesic or xeric prairie.

Water storage should be relatively high on the tops, lower on the side slopes, and as high as possible in the valleys.

There are several materials with which we are working: Columbia River sand, topsoil, topsoil mixed with compost, and subsoil. Each of these may have their place in the landscape.

Soils on nearly flat ridgetops, planted to mesic prairie, will receive very little run-on, and because of their very mild slopes are not expected to be very sensitive to erosion. As a result, water should be retained on the site as long as possible to increase the diversity of potential vegetation the site can support. Vegetation communities on the xeric prairie side slopes will be adapted to shallow soils in highly exposed situations. The valley bottom areas should contain the deepest water-holding soils, designed to store the most water in the profile, retain some standing water, and provide deep root zones for shrubs.



Sand

Silty clay loam

1:1 Soil:compost mix

ST JOHNS LANDFILL
VEGETATION PLAN

SIL Landscape Catena

Figure 1

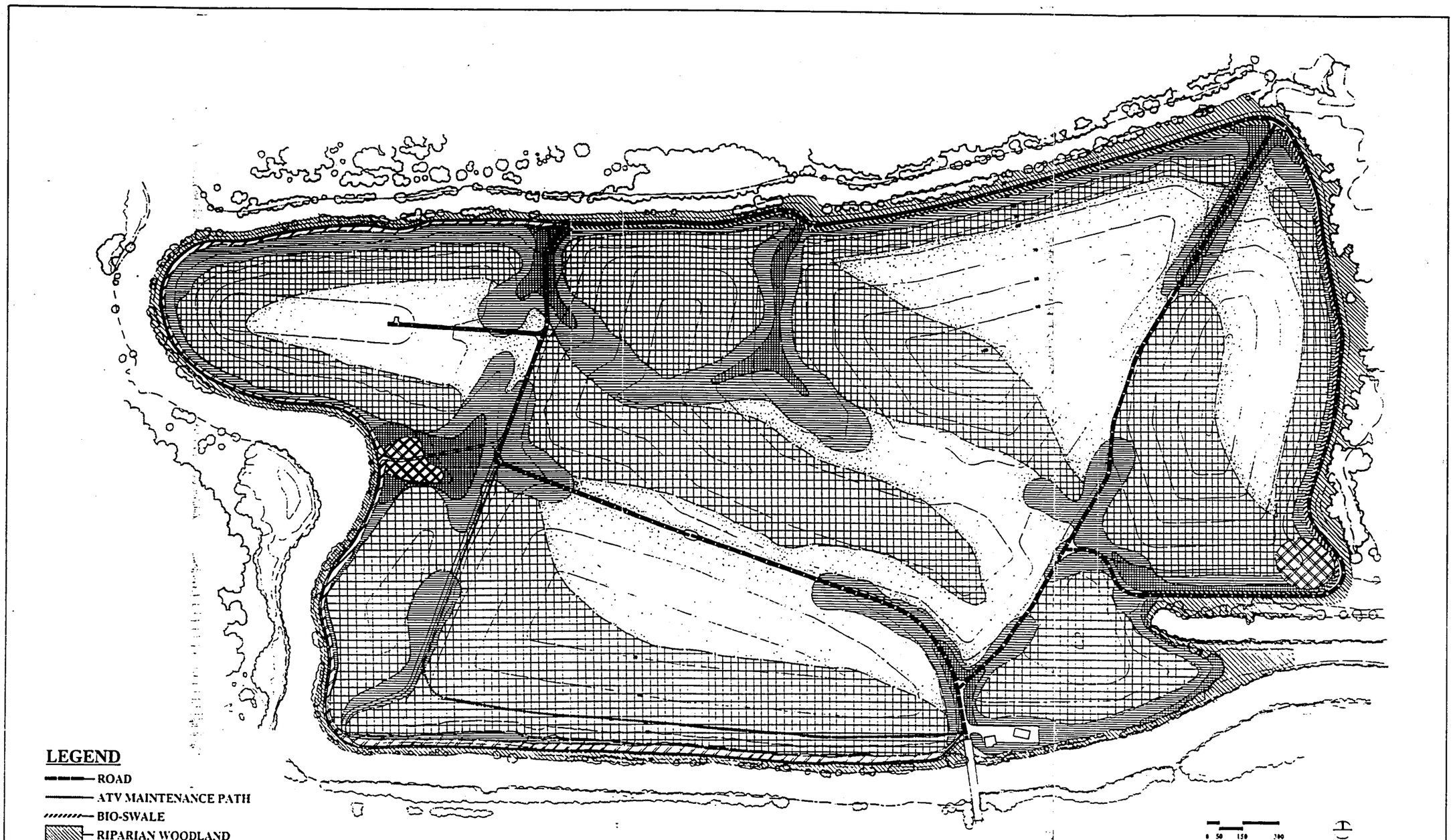
Fishman Environmental Services July 1992

5 DESCRIPTION OF PROPOSED VEGETATION PLAN PLANT COMMUNITIES

5.1 OVERVIEW

The proposed design for the SJL landscape is based on a combination of plant communities carefully chosen to protect the cover system, to thrive in seasonally droughty site conditions, enhance wildlife habitat, and integrate ecologically and visually with the surrounding areas. This plan is presented graphically on the following page. The design is a native plant landscape adapted to the unique growing conditions of the Pacific Northwest. While the great majority of the plant materials specified are from the Willamette Valley, many of the species, particularly the prairie components, are not found in the Portland area. However, they are found in the mid-to-southern Willamette Valley.

Our vision of the closed landfill at some time in the future is of a unique feature in the area. From a distance the landscape appears as an open grassy hill similar in shape and scale to a once common but now rare Willamette valley landscape feature - the grass bald. Grassland wildflowers bloom in the spring and early summer, and insects and songbirds feed in the prairie. In the folds of the hill, draws vegetated with sparsely growing wild rose and snowberry are seen on the upland slopes; lower down the draws, near the base of the slope, thickets of snowberry, rose, hawthorne, elderberry, serviceberry, and chokecherry provide food, cover and connection to the cottonwood gallery forest growing on the banks of the Columbia Slough.



LEGEND

- ROAD
- ATV MAINTENANCE PATH
- BIO-SWALE
- RIPARIAN WOODLAND
- FOREST WETLAND
- WET PRAIRIE/SHRUB EDGE
- LOWLAND SHRUB/TREE
- UPLAND SHRUB
- MESIC PRAIRIE
- XERIC PRAIRIE

0 50 150 300
SCALE : 1" = 150'-0"

NORTH

MAP SOURCE:
DAVID C. SMITH & ASSOCIATES
PARAMETRIX, INC.

SITE MANAGEMENT PLAN

METROPOLITAN SERVICE DISTRICT
SOLID WASTE DEPARTMENT

FISHMAN ENVIRONMENTAL SERVICES

MARK G. WILSON - HORTICULTURIST • WES JARRELL • MIKE FAHA & ASSOCIATES - LANDSCAPE ARCHITECTS

ST. JOHNS LANDFILL COVER VEGETATION PLAN

5.2 PLANT COMMUNITIES FOR CAPPED LANDFILL AREAS

5.2.1 Upland Grassland Cover Types

A Xeric Prairie and a Mesic Prairie are proposed as the primary plant communities for the capped portion of the site.[1] With the exception of the prescribed cover crop, all plant species are based on variants of native grassland plant communities found in the Willamette Valley and the nearby Columbia Gorge. The species proposed are listed below by community type; an asterisk (*) indicates optional plants.

Xeric Prairie Community

Grass Matrix-
Festuca idahoensis (Idaho Fescue)
Koeleria cristata (June Grass)
Poa sandbergii (Bluegrass)
Sitanion hystrix (Bottlebrush Squirrel-tail)
Stipa comata (Needle grass)

Covercrop-
Regreen (Wheat X Wheatgrass)

Wildflowers-
Balsamorhiza sagittata (Balsamroot)
Eriogonum umbellatum (Sulfur Flowered Buckwheat)
Lupinus sericeus (Silkey Lupine)

Mesic Prairie Community

Grass Matrix-
Agropyron caninum (Wheatgrass)
Bromus carinatus (CA Brome-grass)
Elymus glaucus (Blue Wildrye)
Festuca idahoensis (ID Fescue)
Festuca rubra v. rubra (Red Fescue Bunchgrass)
Koeleria cristata (June grass)

[1] "Capped" refers to the landfill area covered with a geomembrane.

Covercrop-
Regreen (Wheat X Wheatgrass)

Wildflowers-
Achillea millefolium (Western Yarrow)*
*Aster chilensis**
Eriophyllum lanatum (OR sunshine)*
Eschscholzia californica (CA Poppy)*
Lupinus bicolor (Annual Lupine)
Lupinus polyphyllus (Big-leaf Lupine)
Solidago canadensis (Goldenrod)*

5.2.2 Upland and Lowland Shrub/Tree Cover Types

Two shallow rooted woody shrub/small tree plant communities are proposed for planting in the draws on the capped areas of the site. The Upland Shrub and Lowland Shrub plant communities are composed of edge species commonly found in Western Oregon. The plants proposed are as follows:

Upland Shrub Community

Widely Spaced Individuals/Patches-
Rosa nutkana (Nootka Rose)
Symphoricarpos albus (Snowberry)

Groundlayer-Xeric Prairie (see above)

Lowland Shrub/Tree Community

Overstory Patches-
Arctostaphyllos columbiana (Hairy Manzanita)*
Arctostaphyllos uva-ursi (Kinickkinick)*
Amelanchier alnifolia (Serviceberry)
Crataegus douglasii (OR Hawthorne)
Philadelphus lewisii (Mock Orange)
Pinus contorta (Shore Pine)*
Prunus virginiana (Chokecherry)
Rosa nutkana (Nootka Rose)
Salix scouleriana (Scouler's Willow)
Sambucus cerulea (Blue Elderberry)
Symphoricarpos albus (Snowberry)

Groundlayer-Mesic Prairie (see above)

5.2.3 Wet Prairie/Shrub Edge Cover Type

A Wet Prairie plant community is recommended for planting in and adjacent to the two detention ponds proposed for the SJL site. Even though the detention ponds as designed in the current specifications will support little or no plant life it is hoped that over time the detention pond management and maintenance practices will permit natural colonization and additional enhancement plantings. Species proposed are commonly found in the mid to upper Willamette Valley.

Detention Pond: Wet Prairie/Shrub Edge Community

Prairie Edge Patches-
Crataegus douglasii (OR Hawthorne)
Myrica californica (CA Myrtle)*
Rhamnus purshiana (Cascara)*
Rosa nutkana (Nootka Rose)
Salix scouleriana (Scouler's Willow)
Salix piperi (Piper's Willow)
Sambucus cerulea (Blue Elderberry)
Symphoricarpos albus (Snowberry)

Groundlayer-
Deschampsia caespitosa (Tufted hair-grass)
Festuca rubra v. rubra (Red Fescue Bunchgrass)
Juncus tenuis (Slender Rush)
Juncus effusus (Soft Rush)

Covercrop-Regreen (Wheat X Wheatgrass)

5.2.4 Bioswale Plant Community Cover Type

A Bioswale plant community composed of emergent wetland and wetland grass species is recommended for planting in the "Road E" biofilter at the interface of the covered and uncovered sections of the landfill. This plant community is designed to function in hydroperiods ranging from hydric to xeric and will offer some measure of storm water pre-treatment. The species selected are a variant of commonly found ephemeral emergent wetlands associated with Willamette Valley Wet Prairies.

Bioswale Community

Groundlayer-
Beckmannia syzigachne (American Slough Grass)
Deschampsia caespitosa (Tufted hair-grass)
Eleocharis palustris (Creeping Spike-Rush)
Elymus glaucus (Blue Wild-rye)
Festuca rubra v. rubra (Red Fescue Bunchgrass)
Juncus tenuis (Slender Rush)
Juncus effusus (Soft Rush)

5.3 PLANT COMMUNITIES FOR UNCAPPED LANDFILL AREAS

5.3.1 Forested Wetland Type

This plant community is recommended for planting adjacent to the Bioswale community on that portion of SJL where we recommend closure of "Road E" and regrading of the road bed. This plant community is also designed to function in hydroperiods ranging from hydric to xeric and should provide some measure of storm water and leachate seep treatment. This plant community, dominated by ash, is a commonly found wetland type.

Forested Wetland Community

Overstory Trees/Shrubs
Crataegus douglasii (OR Hawthorne)
Fraxinus latifolia (OR Ash)
Rhamnus purshiana (Cascara)
Rosa nutkana (Nootka Rose)
Salix scouleriana (Scouler's Willow)
Salix piperi (Piper's Willow)
Sambucus racemosa (Red Elderberry)
Symphoricarpos albus (Snowberry)

Groundlayer-
Beckmannia syzigachne (American Slough Grass)
Deschampsia caespitosa (Tufted hair-grass)
Eleocharis palustris (Creeping Spike-Rush)
Festuca rubra v. rubra (Red Fescue Bunchgrass)
Juncus tenuis (Slender Rush)
Juncus effusus (Soft Rush)

Covercrop-*Regreen* (Wheat X Wheatgrass)

5.3.2 Riparian Woodland Type

This plant community is recommended to be planted between the Forested Wetland/"Road E" and Smith & Bybee Lake or the Columbia Slough. Some fragments of this plant community already exist on site; additional plantings will link these fragments improving site habitat as well as providing additional stormwater and leachate treatment.

Riparian Woodland Community

Overstory Trees-
Acer macrophyllum (Big leaf Maple)
Alnus rubra (Red Alder)
Populus trichocarpa (Black Cottonwood)
Salix lasiandra (Pacific Willow)
Salix sitchensis (Sitka Willow)
Salix scouleriana (Scouler's Willow)

Understory Trees and Shrubs-
Amelanchier alnifolia (Serviceberry)
Corylus cornuta (CA Hazel)
Cornus stolonifera (Red Osier Dogwood)
Lonicera involucrata (Twinberry)
Prunus emarginata (Bitter Cherry)
Rhamnus purshiana (Cascara)
Rosa pisocarpa & R. nutkana (Wild Roses)
Salix piperi (Piper's Willow)
Sambucus cerulea & S. racemosa (Elderberry)
Symphoricarpos albus (Snowberry)

Edge/Groundlayer Grasses and Forbs-
Elymus glauca (Blue Wildrye)
Regreen (Wheat X Wheatgrass covercrop)
Epilobium angustifolium (Fireweed)

6 VEGETATION PLAN IMPLEMENTATION AND MANAGEMENT

6.1 IMPLEMENTATION OVERVIEW BY COVER TYPE

6.1.1 Upland Grassland

Seed is available for all proposed grasses and wildflowers if one season advance notice is given to suppliers. Both grassland plant communities can be seeded directly on the site from late summer until early fall by using any one of the

following types of equipment or techniques: range drill, two stage hydroseeding, broadcast-track, and land imprinting. SJL Subarea 1 Test plots will evaluate the cost effectiveness of range drilling, double stage hydroseeding and broadcast-track as seed planting techniques (see section II). Irrigation of the seeded grasses and wildflowers may be necessary during the late spring-early summer of the first growing season following planting; thereafter irrigation of the grassland would be detrimental. Grasslands are seral communities, therefore, infrequent high mowing will be necessary to rejuvenate them and prevent woody plant invasion.

6.1.2 Upland and Lowland Shrub/Tree

Both shrub/small tree plant communities are to be planted in the late fall-early spring dormant season after the establishment of either the Xeric or Mesic Prairies. These grasslands will serve as a groundlayer for the plantings of woody materials. The shrubs/small trees should be planted on site as small propagules that have been purchased from native plant nurseries, grown on site, or collected and placed as hardwood root or shoot cuttings during the dormant season. In some cases planting collected woody plant seed directly on site may produce good results (see section 6.3). SJL Subarea 1 woody shrub/small tree test plots will determine the soil moisture requirements of selected woody shrubs/small trees and will match these requirements with recommendations for the exact planting position on the slope. Suitability of irrigation with leachate will also be determined in the Subarea 1 test plots. (See Section II)

6.1.3 Wet Prairie/Shrub Edge

The groundlayer of this plant community should be planted by two stage hydroseeding or broadcasting/track method from the late summer until the early fall. Recommendations for the establishment of the woody material are the same as for the Shrub/Tree communities above.

6.1.4 Bioswale

This plant community should be pre-grown from seed and emergent propagules and planted in the early fall as sod mats in order to provide water quality treatment benefits immediately. Occasional mowing and replanting may be necessary from time to time in order to meet water quality objectives. The riparian test plot in Subarea 1 will evaluate the effectiveness of vegetated bioswales. (See Section II)

6.1.5 Forested Wetland

In order to provide water quality treatment immediately, the groundlayer of this plant community should be established in the early fall from a combination of seeded grasses/emergent propagules and pre-grown sod mats. In the early spring of the first growing season the woody understory and overstory materials can be planted from purchased or site-grown 1-5 gallon size nursery container stock. Irrigation of the woody materials should only take place during the first two growing seasons. The riparian test plot in Subarea 1 will determine guidelines for stormwater and leachate treatment, and suitability of irrigation with leachate. (See Section II)

6.1.6 Riparian Woodland

The groundlayer of this plant community should be established first after pest plant eradication (i.e. reed canarygrass and Himalayan blackberry) is carried out. After 2-3 growing seasons, the woody plant understory and overstory species can be established from a combination of nursery and site grown containers and collected hardwood cuttings. Irrigation of the woody plants for the first two growing seasons is recommended.

6.2 NATIVE PLANT ACQUISITION

6.2.1 Native Plant Availability

Native Oregon plant materials have generally been very difficult to obtain. Recently, however, more nursery container grown plants of western Oregon trees & shrubs are becoming available for spring and fall planting seasons if several months advance notice is given. The availability of herbaceous and woody plant seed, however, is still very poor, particularly seed of shrubs, native grasses and forbs. This situation should improve in the long term with increased marketplace demand. Up to date information concerning native plant availability can be obtained from the following sources:

Cascadia Native Landscape Project
(A non-profit organization)
PO Box 82292, Portland OR 97282
information telephone: (503) 236 0395 or
(503) 222 0134

Hortus Northwest: A Pacific Northwest Native Plant Directory and Native Plant Journal (annual edition)
PO Box 955, Canby, OR 97013
Editor: Dale Shank
Publication Cost: $9.00 (post paid)
information telephone: (503) 245 4068 (days)
(503) 266 7968 (eves)

An alternative to outright plant or seed purchase is contract growing and/or contract seed collection. With 1 or 2 year notice and the receipt of a down payment, most native plant nurseries will custom propagate and/or grow plant materials. For information concerning contract seed collection call the Cascadia information number listed above.

6.2.2 Plant Growing at St. Johns Landfill

The economic feasibility of growing native plant materials off the capped surface on lands adjacent to the SJL site should be explored. When evaluating a particular growing site the soil suitability, proximity to irrigation water, and type and availability of planting equipment and/or labor should be considered. Additionally, the construction of a small unheated hoop style greenhouse at the growing site would increase production efficiency and provide winter protection for woody and herbaceous container stock. Considering native plant shortages in the marketplace and the probable site vegetation requirements, the on-site growing of native grasses, trees and shrubs, particularly softwood plant species such as willow and cottonwood, may provide some project cost savings and an excellent environmental education training opportunity for interested local citizens. Supervised volunteer labor could be organized and trained to assist with the planting, maintenance & harvest of nursery materials.

Many native plants are easily propagated from both hard and softwood cuttings or seed placed directly in prepared growing beds or in containers. Several methods of growing native grasses should be explored depending on budget requirements. Medium sized pure stand plots (containing 1 grass species only) could be laid out and sized according to the scale of available planting and harvest labor and/or machinery. Small mixed species plots containing grasses and wildflowers could be laid out for hand seed harvest or dry hay harvest using hand scythes, small gas powered test plot harvesters or tractor mounted side bar cutters. Good site selection and pre-planting preparation is necessary when growing native grasses. One to two years of fallowing and/or herbicide application may be necessary before planting grasses in order to rid the ground of undesirable seedbanks of aggressive non-native species that may out compete native grass seedlings.

6.3 RECOMMENDED PROPAGATION METHODS: WOODY AND EMERGENT PLANTS

Propagation methods are recommended below for different landfill revegetation species, using seed, cuttings, layering, and division.

TREES/SHRUBS	
Acer macrophyllum (Big leaf Maple)	SEED
Alnus rubra (Red Alder)	SEED
Amelanchier alnifolia (Serviceberry)	SEED/ROOT CUTTING
Cornus stolonifera (Red Osier Dogwood)	SEED/STEM CUTTING
Corylus cornuta (Hazel)	SEED/LAYERING
Crataegus douglasii (OR Hawthorne)SEED	
Fraxinus latifolia (OR Ash)	SEED
Lonicera involucrata (Twinberry)	SEED/STEM CUTTING
Philadelphus lewisii (Mock Orange)	STEM CUTTING
Populus trichocarpa (Black Cottonwood)	IN-SITU STEM CUTTING
Prunus emarginata (Chokecherry)	SEED/LAYERING
Rhamnus purshiana (Cascara)	SEED
Rosa nutkana (Nootka Rose)	SEED/STEM CUTTING
Rosa pisocarpa (Swamp Rose)	SEED/STEM CUTTING
Salix lasiandra (Pacific Willow)	STEM CUTTING
Salix piperi (Piper's Willow)	IN-SITU STEM CUTTING
Salix scouleriana (Scoulers Willow)	STEM CUTTING
Sambucus cerulea (Blue Elderberry)	SEED/STEM CUTTING
Sambucus racemosa (Red Elderberry)	SEED/STEM CUTTING
Symphoricarpos albus (Snowberry)	SEED/ROOT & STEM CUTTING
OPTIONAL TREES & SHRUBS	
Arctostaphyllos columbiana (Hairy Manzanita)	STEM CUTTING
Arctostaphyllos uva-ursi (Kinickinick)	STEM CUTTING
Myrica californica (CA Myrtle)	ROOT CUTTING
Pinus contorta (Shore Pine)	SEED
GRAMINOIDS	
Juncus tenuis (Slender Rush)	SEED/DIVISION
Juncus effusus (Soft Rush)	SEED/DIVISION

7 COMPARISON OF NATIVE AND NONNATIVE VEGETATION

The FES Vegetation Plan is based on the use of plant species native to the Pacific Northwest. There are numerous advantages resulting from the specification of species adapted to local physical and biological conditions. A comparison of native plant vs. non-native plant attributes is presented in Table 1.

TABLE 1

OPTION #1: NATIVE PLANT COMMUNITIES	ATTRIBUTE	OPTION #2: NON-NATIVE VEGETATION
higher *	INSTALL COST/ACRE	lower
fall only	SEEDING WINDOW	fall and spring
slower	SEED GERMINATION	faster
none	LIMING	1 x year
good	LOW PH TOLERANCE	poor
none **	FERTILIZING	1 - 2 year
low	WATER REQUIREMENTS	moderate
once/3 years	MOWING	once/year
lower	30 YEAR MAINTENANCE COST	higher
good ***	SHORT TERM EROSION CONTROL	good
good	LONG TERM EROSION CONTROL	poor with no maintenance
poor	FIRE BREAK VALUE	poor
high	VEGETATION STRUCTURAL DIVERSITY	poor
none	ALLELLOPATHY ++	moderate
polyculture +	VEGETATION SPECIES DIVERSITY	monoculture
excellent	WILDLIFE/AVIAN HABITAT	limited
excellent	LONG TERM VEGETATION STABILITY	poor with no maintenance
high	SCENIC/HERITAGE VALUE	low
excellent	INTERPRETIVE EDUCATION POTENTIAL	poor

\+ polyculture - the growing of many species (e.g. a diverse plant community)

\+ allellopathy - the ability of certain plants to inhibit the see germination (or subsequent growth) of other plants.

* per estimate

** after initial fertilization

*** if seeded with temporary cover crop

8 COMPARISON OF 30 YEAR COSTS

TABLE 2

COMPARISON OF 30 YEAR PER ACRE MAINTENANCE COSTS FOR THE PLANTING OF NATIVE AND NONNATIVE GRASS MIXTURES

COST FACTORS	NATIVE	NON-NATIVE
ESTABLISHMENT seed cost	higher cost/weight	lower cost/weight
LIMING labor & materials	$ 0 (not necessary)	$1700.00/Acre (1 X Year)
FERTILIZATION labor & materials	$ 0 (not necessary)	$2125.00 - $4250.00/Acre (1-2 X Year)
IRRIGATION	$ 0 (drought resistant)	$?? (irrigation beneficial)
MOWING equipment & operator	$100.00/Acre (once/year)	$100 - $200/Acre (1 - 2 Mows/Year)
TOTAL COSTS	**$100.00/Acre/Year ***	**$3925.00 - $6150.00/Acre/Year**

NOTE: The labor costs for the establishment of native and non-native grass mixtures are similar.

* plus higher/acre seed costs

II. ST JOHNS LANDFILL COVER VEGETATION PLAN - SUBAREA 1 TEST PLOT PLAN

1 OVERVIEW

SJL Subarea 1 vegetation will be planted in 1992. This Test Plot Plan was designed to establish and monitor the successes and failures of different vegetation establishment techniques, species mixes, plant survival, erosion, and soil/moisture characteristics. Methods for monitoring wildlife use are also recommended. The information gained from the monitoring program can be applics to vegetation planning for the remainder of the landfill.

2 TEST PLOT DESIGN AND LAYOUT

Test plots are to be established to assess the comparative benefits of different soil preparations, soil materials, plant materials, and establishment techniques. The infinite number of potential treatments must be limited to those which will provide the greatest degree of useful information about slope stability, soil erosion stability, soil fertility, plant establishment and growth, and relative benefits of different planting strategies.

The size of the test areas are to be realistically large, so that they provide significant buffer areas and they can be prepared with full-scale field equipment such as range drills.

There are four test plot types; locations are shown in the Figure on the following page.

TP1. Interaction between soil types, prairie type, and plant establishment techniques;

TP2. Interaction between soil type, landscape position, and shrub success;

TP3. Erosiveness and effects of coarse woody debris (i.e., logs);

TP4. Establishment and management of bioswale/riparian woodland.

Test Plot 1. (TP1.)

This test plot will consist of three 200' wide strips running north-south over the ridge in Subarea 1. Each strip will be composed of a different soil profile:

Soil Type 1. The easternmost strip of TP1 will consist of the specified soil profile specified in the Subarea 1 contract document (METRO April 1992)

Soil Type 2. The central strip of TP1. will consist of the FES proposed catena of soils.

Soil Type 3. The westernmost strip of TP1. will consist of a variation of the FES proposed catena of soils (Table 3).

Test Plot 2. (TP2.)

This test plot will measure the establishment success and subsequent growth of shrubs and small trees planted in a previously seeded groundlayer of grasses and wildflowers. These Shrub/Small tree Test Plots (labeled T-1, T-2, and T-3 on the Subarea 1 Test Plot Plan) are to be planted as transects perpendicular to the drainage flow pattern in the channel on the northeast portion of Subarea 1. Shrubs/Small trees should be planted at 3' intervals in double lines from the bottom of the valley to half way up the slopes. This will allow an analysis of establishment success relative to landscape position. The transects (T-1 & T-2) should consist of *Salix scoulerina* (willow) and *Amelanchier alnifolia* (serviceberry). The transect (T-3) should consist of *Rosa nutkana* (Nootka rose) and *Symphocarpus albus* (snowberry)

Soil Type 4. The easternmost strip of TP2. and TP3. (detailed below) will also be based on the FES proposed catena theme. The topsoil layer thickness will be deep enough to support the growth of shrubs and small trees.

TABLE 3
SUBAREA 1 TEST PLOT SOIL PROFILES SUMMARY

SOIL PROFILE	SOIL TYPE 1	SOIL TYPE 2	SOIL TYPE 3	SOIL TYPE 4
C Sand B Subsoil A Topsoil **Total Depth**		1.0 ft 9 ins. - 6 ins. Existing topsoil plus 6 inches new subsoil 6 ins. - 3 ins. Compost disced into top 3 ins. **2.25 ft. subsoil**	1.5 ft. 9 ins. - 6 ins. Existing topsoil plus 6 ins. new subsoil 6 ins. - 3 ins. Compost disced into top 3 ins. **2.75 ft. subsoil**	
C Sand B Subsoil A Topsoil **Total Depth**		1.5 ft 6 ins. - 8 ins. New subsoil 4 ins. - 2 ins. compost disced into top 2 ins. **2.33 ft subsoil**	1.5 ft. - 3 ins. New subsoil - 3 ins. Compost disced into top 3 ins. **2.0 ft. subsoil**	
C Sand B Subsoil A Topsoil **Total Depth**				1.0 ft. 18 ins. - 15 ins. Existing topsoil plus 6 ins. imported subsoil 6 ins. - 3 ins. Compost disced into top 3 ins. **3.0 ft. subsoil**
C Sand B Subsoil A Topsoil **Total Depth**	1.5 ft. 6 ins. - 6 ins. Existing topsoil 6 ins. - 3 ins. Imported subsoil 3 ins. compost disced 6 ins. deep **2.5 ft.**	1.5 ft. 6 ins. - 6 ins. Existing topsoil 6 ins. - 3 ins. Imported subsoil 3 ins. compost disced 6 ins. deep **2.5 ft. deep**	1.5 ft. 6 ins. - 6 ins. Existing topsoil 6 ins. - 3 ins. Imported subsoil 3 ins. compost disced 6 ins. deep **2.5 ft. deep**	

TP3.Erosion plots.

Within the shrub test plots, we have the continuous long slopes needed to effectively test the effects of soil types on sensitivity to erosion. As seen from the test plot figure, the steep northwest portion of the test area will be split into a stretch which receives cull logs placed over the soil. These logs are in place to retain any surface runoff water longer on the site, thereby increasing infiltration rates and decreasing the potential for gully formation. In addition, they provide increased diversity of microhabitat and, as they decompose, add stable organic matter to the soil. We will intentionally use cull logs which are already infected with wood rot fungi, thus increasing the potential decomposition rates.

TP4.Bioswale/riparian woodland test plots

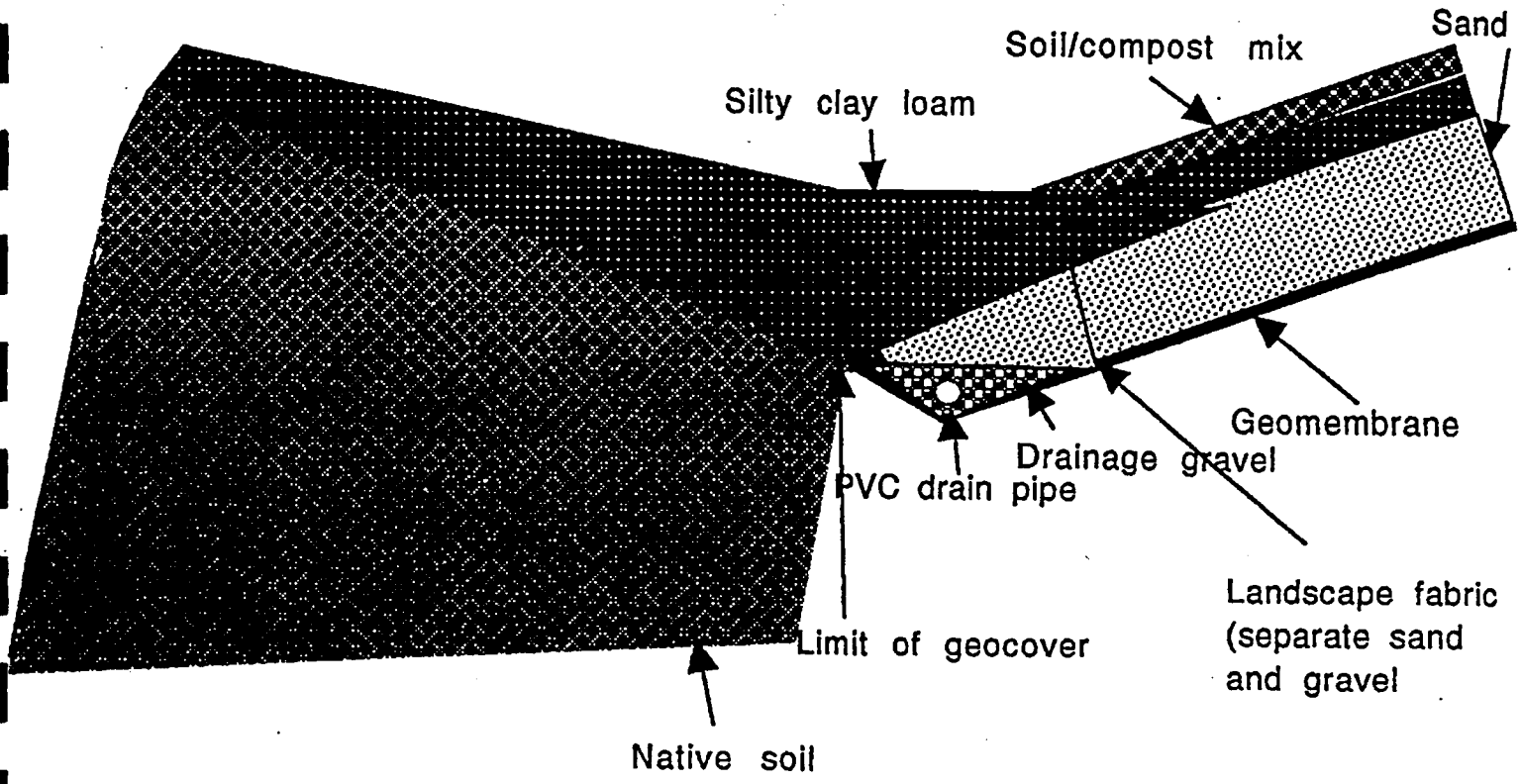
We propose to close off the road from just east of Seep Leachate SP-1 as designated on maps, westward to the point at which drainage breaks from north to south. The road should be regraded to provide a counterslope flow. The swale should be broken up with small check dams at 50' intervals. The dams should be as high as possible without causing surface water to overflow the banks into the slough.

Additional low permeability (10^{-5}) soil should be placed on top of the original soil to minimize infiltration and keep water on the site longer (see Figure 2).

The bioswale area will be planted with the sod mats described in Section 6.1.4. In addition, the areas on the banks themselves will be planted with shrubs.

The riparian zone below the bioswale will be densely planted with native forested wetland and riparian woodland species.

See the Soil Profile Summary Chart, the Subarea 1 Test Plot Plan and the seeding specifications elsewhere in Section II of this report.



Sand

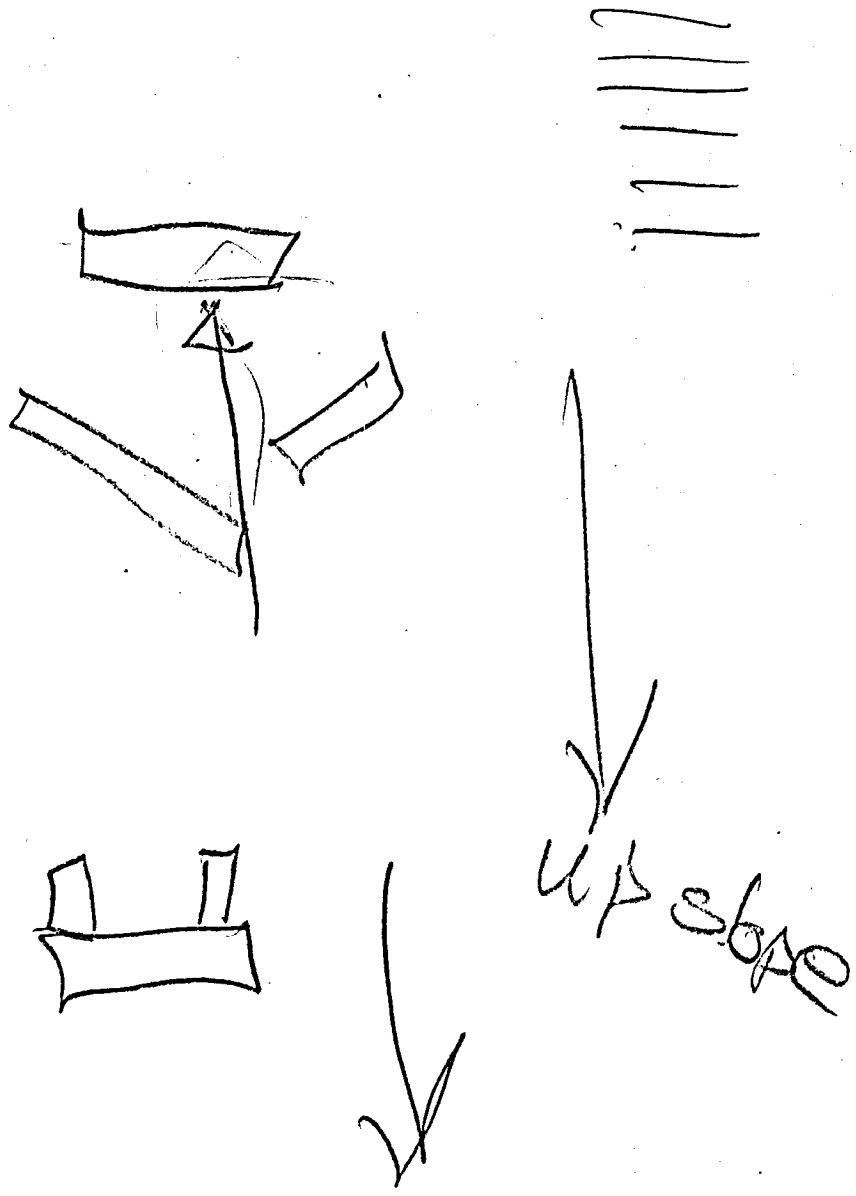
Silty clay loam

1:1 Soil:compost mix

ST JOHNS LANDFILL
VEGETATION PLAN

Section:
Bioswale Riparian Test Plot
Figure 2

Fishman Environmental Services July 1992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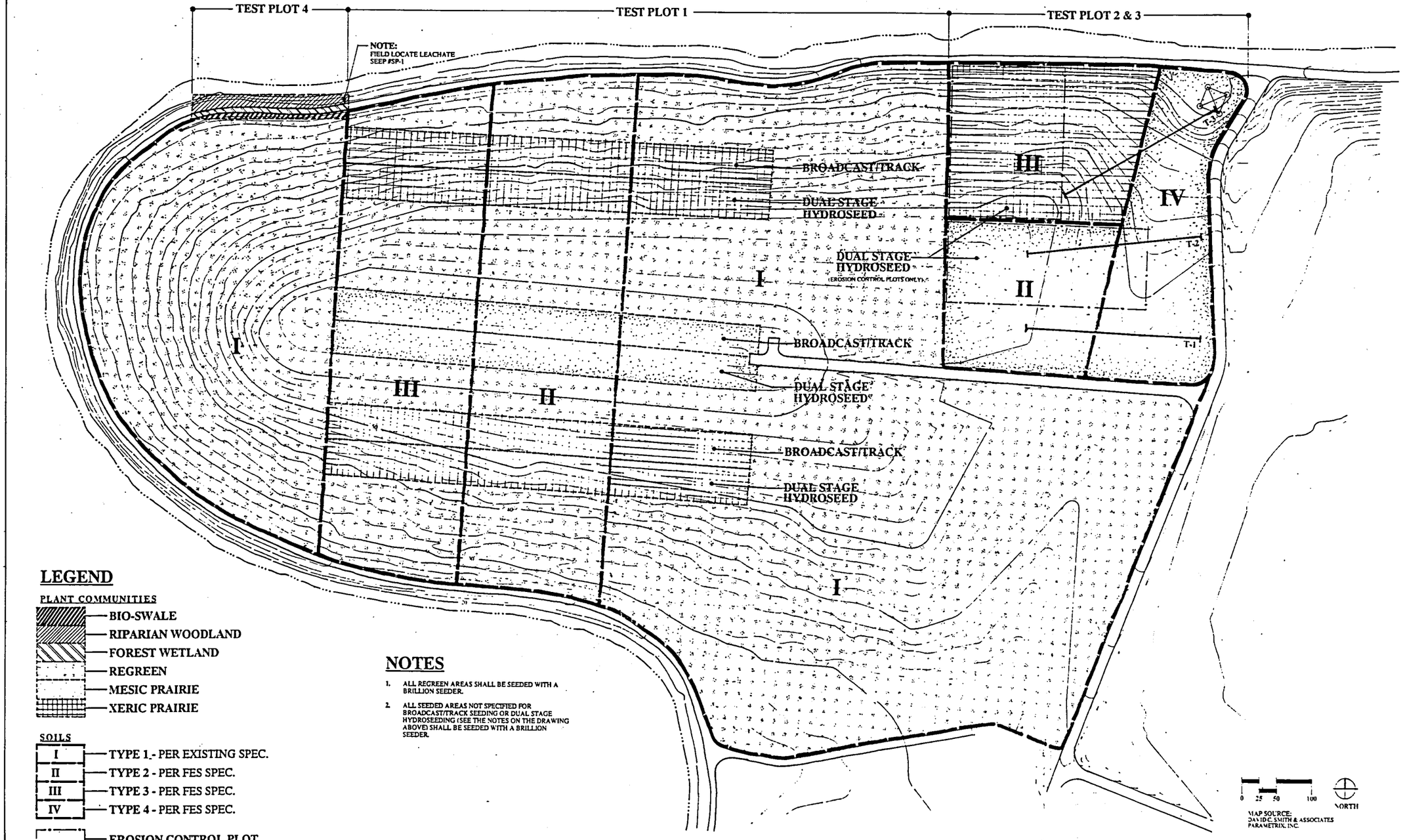

LEGEND

PLANT COMMUNITIES

- BIO-SWALE
- RIPARIAN WOODLAND
- FOREST WETLAND
- REGREEN
- MESIC PRAIRIE
- XERIC PRAIRIE

SOILS

- I — TYPE 1 - PER EXISTING SPEC.
- II — TYPE 2 - PER FES SPEC.
- III — TYPE 3 - PER FES SPEC.
- IV — TYPE 4 - PER FES SPEC.

- EROSION CONTROL PLOT (PLACE LOGS ON HALF OF PLOT)
- TEST PLOTS (TRANSECTS)
  - T-1 — ROSA NUTKANA, SYMPHORICARPOS ALBUS
  - T-2 — AMELANCHIER ALNIFOLIA, SALIX SCOULERIANA
  - T-3 — AMELANCHIER ALNIFOLIA, SALIX SCOULERIANA

NOTES

1. ALL REGREEN AREAS SHALL BE SEEDED WITH A BRILLION SEEDER.
2. ALL SEEDED AREAS NOT SPECIFIED FOR BROADCAST/TRACK SEEDING OR DUAL STAGE HYDROSEEDING (SEE THE NOTES ON THE DRAWING ABOVE) SHALL BE SEEDED WITH A BRILLION SEEDER.

METROPOLITAN SERVICE DISTRICT
SOLID WASTE DEPARTMENT

FISHMAN ENVIRONMENTAL SERVICES

MARK G. WILSON - HORTICULTURIST • WES JARRELL • MIKE FAHA & ASSOCIATES - LANDSCAPE ARCHITECTS

SUBAREA 1 TEST PLOT PLAN

ST. JOHNS LANDFILL COVER VEGETATION PLAN

3 PROPOSED SEQUENCING OF WORK PLAN

The large scale experimental plots designed for Subarea 1 will need to be installed following a complex sequence of steps. This installation is outlined below.

AUGUST 1992:

* Order specified plant material/Submit downpayment to vendors. Request delivery no later than 9/1/92. Submit seed invoices or source verification to project manager.
* Place old stripped temporary cover soil on top of sand layer in all areas of Subarea 1 as specified by FES.**
* Complete FES specified placement and grading of imported soil on all areas of Subarea 1.**
- Submit soil samples to project manager for nutrient analysis.
- Incorporate compost in top 4 inches of final cover soil/Disc to mix.

SEPTEMBER 1992:

- Add fertilizers as specified/Disc top 4 inches of soil.
- Prepare seedbeds in all areas of Subarea 1 with disc and harrow.
- Layout test plots as specified.

SEPTEMBER 20 - OCTOBER 10, 1992:

- Seed all test plots as specified using the following equipment and methods: Broadcast seed / track, double stage hydroseeding and brillion seeding (see plan for method).
- Place slope stabilization logs in test plots then seed erosion control test plot areas using double stage hydroseeding method.
- Seed FES specified Regreen cover crop on remainder of Subarea 1 areas using a brillion seeder.

* Implement erosion control specifications.

OCTOBER 1992 - FEBRUARY 15, 1992 (weather dependant)

- Monitor vegetation a minimum of once monthly / Repair erosion and/or reseed with cover crop as necessary.

FEBRUARY 15-MARCH 15 (weather dependent)

- Reseed all areas as necessary to meet warranty. Follow initial seeding specifications.

*=Not in this contract (included for reference and coordination)
**=Refers to St Johns Landfill Cover Vegetation Plan report by Fishman Environmental Services (FES).

MAY 15 (weather dependent)
- Initiate test plot monitoring
- Prepare site for summer fallowing and/or re-planting as necessary
- Initiate woody plant irrigation using temporary drip system
- Initiate herbaceous cover irrigation using ag field system
- Initiate pest plant control strategies
- Order replacement plant materials as necessary

LATE JULY (weather dependent)
- Cease herbaceous cover irrigation

JUNE-SEPTEMBER, 1993
- Continue test plot monitoring, pest plant eradication and woody plant irrigation
- Reevaluate planting and erosion control strategies
- Plan for fall replanting season

4 PROPOSED IMPLEMENTATION SPECIFICATIONS FOR TEST PLOTS

4.1 SITE PREPARATION OVERVIEW

Careful site preparation will be critical in order to successfully vegetate the Subarea 1 test plots with native herbaceous species. The existing Ryegrass (*Lolium spp.*) temporary cover of the entire SJL site will be very difficult to undo as the soil seedbank of the temporary cover soil is most likely contaminated with much ryegrass seed.

Burying the temporary cover soil beneath stockpiled imported soil that has been amended with compost is a viable ryegrass control strategy; however, the imported soil should be certified weed and crop seed free before it is put in place and all subsequent discing and seedbed preparation work should be done so that only the top 4" of the imported soil profile is disturbed. This strategy will avoid bringing more ryegrass seed to the surface. An additional control strategy is to initiate a fallowing of the field during the summer prior to planting the native grasses in the early fall. A suggested fallowing schedule is as follows:

Fall
Close mow area planned for fallowing
Early Spring (weather dependent)
Apply herbicide to area after non-native grass begins spring growth
Wait 10 days then re-apply herbicide to area
Late spring-Early Fall
Initiate discing of area
Irrigate area with 1" of water
Wait 3 weeks then disc area
Repeat disc, irrigate, disc monthly until planting time

Fallowing can not be fully implemented in the summer of 1992 for closure of Subarea 1 due to the lateness of the season and ryegrass may contaminate planned test plots. Hopefully, more timely ryegrass control strategies can be implemented in future SJL Subarea closures.

4.2 SUBAREA 1 SOIL SPECIFICATIONS

The following specifications are recommended to provide the substrate needed for the vegetation plan:

Sand: As specified in documents: also, containing no plant growth inhibitors.
Silty clay loam:
No weed or crop seeds
pH in saturated paste: 5.8 - 6.5
Available nitrogen: <10 mg N/kg, sum of nitrate and ammonium
Available phosphorus: 100 - 150 mg/kg (ppm) in Bray 2 extract
Available potassium: 150 - 250 ppm in ammonium acetate, pH 7 extract
Exchangeable calcium:magnesium ratio >2.0
Boron: 1 - 5 ppm (mg/kg dry soil) in hot water extract
Cation exchange capacity: >18 meq/100g
Water holding capacity: $>20\%$ plant-available water at filed capacity
Compost: Low available nutrient, stabilized compost material.

4.3 SOIL INSTALLATION

The temporary cover soil, stripped to install the geomembrane, should be the first layer of soil placed on top of the sand layer. The imported soil should then be placed on top and amended as specified (see Table 3).

Nearly Flat Ridgetops-Mesic Prairie

To set up the site, first 1' of sand should be laid down and covered with 1' of silty clay loam subsoil. Approximately 3" of compost should be disced into the surface 3" of subsoil, thereby providing a 1:1 compost:soil mixture in the surface 6". This produces the "neo-A-horizon" which will have reasonably high fertility, and moderately high infiltration rates. The "neo-B" horizon will have lower infiltration rates and fertility, but still support good root growth. By discing the compost into the soil rather than having a compost-soil mixture laid over the prepared subsoil, we should save the costs of compost-soil mixing and we will generate an irregular interface between the A horizon and the silty clay loam B horizon, allowing better rooting and water transport between the horizons.

Sideslopes-Xeric Prairie

The sand layer should be 1.5' thick, with 8" of low-permeability subsoil placed over it. The low-permeability subsoil should have 2" of compost disced into its surface 2", to improve the seedbed and stabilize surface erosion. The constructed soil has a 4" A horizon, a 6" B horizon, and a 1.5' C horizon.

Valley Bottoms

One foot of sand, covered with 2' of silty clay loam soil, with 3" of compost rototilled into the surface 3" of soil. The soil has 6" of A horizon, 1.75' B horizon, and 1' C horizon.

4.4 PLANT MATERIAL/SEEDING OVERVIEW

4.4.1 Seeding Overview

Native grasses are poor competitors during the first season of growth, which necessitates co-planting a temporary covercrop unless the site is free of non-native grasses. The covercrop (usually a sterile cereal grain) germinates and grows quickly, preventing erosion and claiming space during the first winter and into the first growing season. The native grass seedlings benefit from the shade provided by the cover crop during the first summer growing season after planting, and some late spring-early summer irrigation is usually beneficial. Depending on the severity of the second winter season, the cover crop may not survive until the spring of the second growing season; if the covercrop does survive, an early season high mowing of the covercrop only is sometimes recommended. By the late spring of the second growing season, the deep roots of the native grasses support strong top growth and they soon overtop the declining covercrop. The covercrop Regreen, a sterile hybrid wheat X wheatgrass, is specified to be planted with native grasses in Subarea 1 test plots and in pure stands elsewhere in Subarea 1 to prevent erosion for 1-2 years.

Planting a community of native grasses and wildflowers requires specialized equipment or the adaption of conventional equipment because of the differing seed sizes and need to randomly plant them in a field. We propose that several methods of grassland seeding be implemented in the planting of the Subarea 1 testplots in late September-early October: two stage hydroseeding, range drilling, and broadcast/track. Many companies in the Portland metro area are qualified to double stage hydroseed as specified. A 14' Metalmaster RM-10 range drill available for rent @ $5.00/Acre is available from: Crook County/OSU Extension Service in Prineville, OR.[2] Seed broadcasting should be done with a hand seeder

[2] Contact Tim DeBoot for further information; (503) 447-6228. The Crook County range drill will be used for 1 day to plant a prairie in the Columbia Gorge early next fall; to coordinate use contact Mark Wilson.

able to be calibrated for sowing very small wildflower seed; a Cyclone seeder or comparable would be suitable. Tracking should be done with a Cat or similar machinery. In future years an additional method of seeding with a land imprinter should be tried. A Dixon Land Imprinter is in use at the Squaw Butte Range Experiment Station in Eastern Oregon [3] and it is available for use. It is probably uneconomical, however to truck it to Portland for the fall 1992 planting of test plots.

4.4.2 Seeding and Planting Techniques

Site Preparation

Specifications for Herbicide Applications

Application Goal: Achieve an 80% kill of grasses and other annual and perennial weeds alive at the time of application.

Materials: *Roundup* or *Rodeo* Herbicide (use *Rodeo* if the ground is to be treated has standing water at the time of application)
Rate - 3 quarts per acre

Ammonium sulfate fertilizer (21-0-0) (translocation enhancer)
Rate - 20 pounds per 100 gallons spray water

LI-700 aquatic surfactant (use with *Rodeo* only)
Rate - 8 ounces per acre

Execution: If site to be treated is bare ground, apply 1" of irrigation water to the area, then wait 3 weeks before treating with herbicide.

Make initial herbicide application. Wait 10 days. Make second herbicide application.

[3] Call Dave Ganskoff - (503) 573-2064 for more information.

Seeding Techniques

Dual Stage Hydroseeding

Materials-

1) Native grass / covercrop / wildflower mixes and application rates specified in planting plan. Source verification required.
2) Hydroseed slurry mix shall consist of the following: Seedmix, virgin wood fiber mulch @ 2000 #/Ac, tacifier @ 60#/Ac, **NO FERTILIZER**

Execution-

1) Plant seed only at times when local weather and other conditions are favorable to the preparation of the soil and to the germination and growth of seed.
2) Clean slurry tank and all hoses off site before loading grass/wildflower mix. Insure that no other type of seeds are present in the application equipment.
3) Hydroseed all areas in a two stage process: First, apply all seed and 10% of the mulch, secondly; track over seed/mulch with a cat or similar machinery; thirdly, apply the remaining 90% of the mulch over the top of the initial application.
4) Sow seeded areas evenly with a hydroseeder. Agitate slurry mix periodically as necessary to insure an even mix of ingredients.

Sod Mat Growing Techniques

Materials-

Supplies:

4 mil. plastic sheeting
CHOIR Natural fiber Erosion control fabric (Dekowe 900 or comparable)
2 x 4 lumber / nails
"Reemay" crop cover

Growing Media:

1 part- Weed free native soil from placement site
9 part- Potting compost (w/ no incorporated fertilizers)
6 part- Coarse masons sand - 30%
3 part- Fine river sand (with fines) - 15%
1 part- "Turface Regular" soil amendment - 5%

Seed:

Beckmannia syzigachne (American Slough Grass)
Deschampsia caespitosa (Tufted Hair Grass)
Elymus glaucus (Blue Wildrye)
Festuca rubra v. rubra (Red Fescue Bunchgrass)

Emergent propagules (1" x 1" plugs):

Eleocharis palustris (Creeping spike-rush)
Juncus effusus (Soft Rush)
Juncus tenuis (slender Rush)

Execution-

-Start growing sods by mid July for fall placement.
-Select a level partly shaded surface for growing sods.* (Recommend concrete walkway or comparable)
-Construct frame of 2 x 4's to fit surface. (3' x 6' maximum)
-Lay 4 mil. plastic sheeting on level growing surface and over the top edge of frame. Secure edges forming a plastic bathtub.
-Cut and lay CHOIR cloth to fit over plastic on bottom of growing frame.
-Mix dry growing media ingredients and fill growing frame to within 2" of top.
-Plant emergent propagules on 2' centers in media.
-Seed grasses on media at the rate of 1 seed per 1 sq. inch of surface area.
-Rake or roll seed to insure good seed-soil contact.
-Water media thoroughly. Cover with "Reemay" crop cover.
-Fertilize bi-monthly with appropriate turf fertilizer.

* High light levels may inhibit germination of seeds. Covering the seeded media with black plastic for 5-7 days will speed germination.

Planting Techniques: Woody Plants and Dormant Cuttings

Materials-

All plants shall be nursery stock except hardwood cuttings. Nursery stock shall be grown from propagules or seed collected from Western Oregon or Western Washington sources only. Nursery source verification will be required for all plant materials used on the project and no substitutions will be permitted without written approval from Project Manager. Provide plants with habit of growth that is normal for the species, sound, healthy, vigorous, and free from insects, diseases, and injuries and equal to or exceeding measurements specified. Provide methods of handling according to the code of standards dated May 2, 1986, as recommended by the American Association of Nurserymen.

Hardwood cuttings shall consist of healthy, vigorous, one to three year old wood from plants growing in full sunlight and obtained from nearby approved drainage areas identified by the Project Manager. Cuttings shall be from 1 to 2 feet in length and between 1/4 and 3/4 inches in diameter. Each piece shall contain a minimum of two dormant buds per foot of length.

All hardwood cutting stock shall be gathered and stored at temperatures between 33 and 37 degrees F. Discard the tip portion (4 inches) of shoots. Make the basal cut straight and just below a dormant bud; make the top cut on a slant 1/2 inch to 1 inch above a dormant bud. The contractor is responsible for protecting cutting stock from sun, wind, freezing, drying or injury before or during planting. Cuttings shall not be gathered if temperature is below 32 degrees F.

Execution-

Locate new planting where shown on plans, except make approved adjustments where obstructions below ground are encountered or where changes have been made in the construction. Excavate circular pits with vertical sides a minimum of two feet greater than the diameter of the ball.

For trees and shrubs excavate pits to depth sufficient to accommodate ball or roots when plant is set to finished grade. Place 3 inches of compacted soil mixture in the bottom of the pit. Set plants upright. Remove wire, burlap, and surplus binding from top and sides of balls. Spread roots in normal position. Cut all broken or frayed roots off cleanly. Place soil and compact carefully to avoid injury to roots and to fill voids. When hole is nearly filled, add water as necessary and allow to soak away. Fill hole to finished grade. Form shall saucer around plant by placing ridge of topsoil around edge of pit.

Plant trees before surrounding smaller plants and covers are placed. Position trees as shown on plans or where spacing dimensions or locations are not clear, as approved.

For planting of hardwood cuttings, use a dibble of a diameter slightly smaller than the cutting to prepare a pilot hole in the soil. Insert the prepared cutting slant end (top) up into the hole deeply enough so that just one dormant bud shows above the ground.

4.4.3 Seeding and Planting Warranties

<u>Seeding Warranties</u>

The contractor shall guarantee a satisfactory stand of the hydroseeded groundlayer. A satisfactory stand is defined as:

1. Ninety percent or more of the ground covered with grasses and wildflowers.

2. No bare spots larger than one square foot.

Planting Warranties

Contractor shall warrant that a minimum of 80% of the trees and shrubs shall be alive at the end of the first growing season following planting. The Project Manager shall inspect the plantings at the end of the first growing season and if less than 80% of the trees, shrubs and emergent plants are alive, Contractor shall replace, at no charge to the METRO, sufficient plants to achieve the 80% survivability rate.

4.5 PROPOSED PLANT MATERIAL AVAILABILITY AND SOURCES

NOTE: All plants and seed except as noted are available as of July 9, 1992; however, availability is subject to change without notice. Normally, a minimum of 6 months advance notice and downpayment on order is recommended.

PLANT SPECIES	SOURCES
RECOMMENDED TREES/SHRUBS (1, 3, and 5 gallon containers) *Acer macrophyllum* *Alnus rubra* *Amelanchier alnifolia* *Cornus stolonifera* *Corylus cornuta* ***SOLD OUT*** *Crataegus douglasii* *Fraxinus latifolia* *Lonicera involucrata* *Philadelphus lewisii* *Populus Trichocarpa* *Prunus emarginata* ***SOLD OUT*** *Rhamnus purshiana* *Rosa nutkana* *Rosa pisocarpa* ***SOLD OUT*** *Salix lasiandra* *Salix piperi* ***SOLD OUT*** *Salix scouleriana* *Sambucus cerulea* *Sambucus racemosa* *Symphoricarpos albus* OPTIONAL TREES AND SHRUBS: 1, 3, and 5 gallon containers *Arctostaphyllos columbiana* *Arctostaphyllos uva-ursi* *Myrica californica* *Pinus contorta*	ALL TREES/SHRUBS AVAILABLE FROM: Forestfarm Nursery 990 Tetherow Road Williams, OR 97544 (503) 846-6963 Balance Nursery 27995 Chambers Mill Road Lorane, OR 97451 (503) 942-5530

NOTE: All plants and seed except as noted are available as of July 8, 1992; however, availability is subject to change without notice. Normally, a minimum of 6 months advance notice and downpayment on order is recommended.

PLANT SPECIES	SOURCES *
RECOMMENDED GRASSES: seed	
Agropyron caninum	**SOLD OUT**
Beckmannia syzigachne	DAV/WPS
Bromus carinatus	DAV/POS
Deschampsia caespitosa	DAV/WPS
Elymus glaucus	POS/WPS
Festuca idahoensis	DAV/NP/RB
Festuca rubra v. rubra	POS/POW
Koeleria cristata	**SOLD OUT**
Poa sandbergii	DAV/GRAN/RB
Sitanion hystrix	DAV/GRAN
Stipa comata	POW/NP/POS
Regreen (Covercrop)	DAV
RECOMMENDED GRAMINOIDS: 1 x 1 plugs	
Eleocharis palustris	BAL/MIL
Juncus tenuis	BAL/MIL
Juncus effusus	BAL/MIL
RECOMMENDED FORBS: seeds	
Lupinus bicolor	FROS
Lupinus polyphyllus	FROS
Lupinus sericeus	GRAN
OPTIONAL FORBS: seed	
Achillea millefolium	FROS
Aster chilensis	FROS/GRAN
Balsamorhiza sagittata	DAV/FROS/GRAN
Eriogonum umbellatum	GRAN
Eriophyllum lanatum	WPS
Eschscholzia californica	DAV/GRAN
Solidago canadensis	FROS/GRAN

* See next page for addresses and phone numbers of sources.

SOURCE ADDRESSES AND PHONE NUMBERS

BAL — Balance Restoration Nursery
27995 Chambers Mill Road
Lorane, OR 97451
(503) 942-5530

DAV — Davenport Seed
PO Box 187
Davenport, WA
(800) 828-8873

FROS — Frosty Hollow
PO Box 53
Langley, WA 98260
(206) 221-2332

GRAN — Granite Seed
1697 West 2100 North
Lehi, UT 84043
(800) 992-5040

NP — Northplan Seed Producers
PO Box 9107
Moscow, ID 83843-7746
(208) 882-8040

POS — Pacific Open Space
PO Box 744
Petaluma, CA 94953
(707) 769-1213

POW — Plants of the Wild
PO Box 866
Tekoa, WA 99033
(509) 284-2848

RB — Round Butte Seed
PO Box 177
Culver, OR 97734
(503) 546-5222

WPS — Willamette Prairie Seed
434 NW Sixth Ave, Suite 304
Portland, OR 97209
(503) 222-0134

Forest Farm
990 TeThrow Road
Williams, OR. 97544
(503) 846-6963

Quail Ridge Nursery
Molalla
(503) 829-6326

4.6 EROSION CONTROL

4.6.1 Overview

The following goals and objectives for soil and slope stabilization have been formulated in concert with the vegetation plan for the closure of the St. Johns Landfill. Prevention of sedimentation impacts to open water and wetland environments is an important element of the erosion and sediment control plan.

The landfill comprises approximately 236 acres and includes about twenty-one sub-basins. The interfluve areas are characterized by slopes of 10% to 15%, but slope gradients of perimeter areas are 20% or greater. An extensive area of the landfill bordering on the Columbia Slough has slopes in the intertidal zone in excess of 20%. The final drainage plan specifies the use of broad swales and traditional v-shaped drainage ditches which will collect stormwater from the interfluves and convey it via perimeter arterial ditches to sedimentation basins, bio-filter swales, and designated outfalls. Gradients of swales and ditches draining sub-basins range from less than 1% of grade to about 8% of grade; however, there are limited reaches of drainage routes in peripheral areas discharging to receiving waters at 15% of grade. Maximum finish-graded slope lengths will range from approximately 200 feet to over 400 feet.

4.6.2 Erosion Control Plan Focus

Subarea 1 of the St. Johns Landfill is a 35 acre site which possesses physical features characteristic of much of the remainder of the landfill. It possesses all slope aspects, a range of both slope steepnesses and lengths, and several surface drainageways. It is therefore an ideal area in which to test various vegetative treatments, seed application methods, and tolerance levels of plant associations to differing soil moisture regimes.

Imported cover soils will contain varying percentages of silty clay loam and composted organic material at varying depths over subsoil and/or sand. The relationship of plant vigor to the variables of topsoil, underdrain materials, slope position, and aspect will be studied in Subarea 1 so that soil and vegetation prescriptions can be made for the remainder of the landfill.

This element of the St. Johns Landfill Vegetation Plan focuses on model erosion and sediment control approaches which will be applied and monitored in Sub area 1, and revised for application on the remaining portion of the landfill.

4.6.3 Soil and Slope Stabilization Goals

1. Provide erosion and sediment control planning and monitoring to protect open water and wetland environments from the sedimentation impacts of stormwater drainage from the St. Johns landfill during construction activities associated with establishment of final cover vegetation.

2. Protect landfill cover soils from degradation by sheetwash and erosion.

3. Provide test plots to assess the relationships among vegetative cover, slope steepness, slope location, slope length and aspect on sediment production and transport.

4. Prescribe means of protecting drainage conduits and biofiltration systems from sedimentation.

5. Test erosion control materials.

4.6.4 Soil and Slope Stabilization Objectives

1. Limit or break up slope lengths to avoid the potential for the formation of rills and gullies during the planned life-expectancy of the landfill cover and vegetation. Accomplish this by the following means:

a. apply cross-slope texturing treatments such as discing, scarifying, or other means which can create terracettes or other micro-topography to break up concentrated flows, allow mid-slope sediment deposition, and encourage subsurface flow rather than surface sheetflow of stormwater;

b. construct cross-slope grade-breaks, rolling dips, benches, or other means of providing mid-slope water stops and level spreaders to accomplish the functions listed in a. above, at regular intervals on unbroken slopes of given steepness and length;

c. close and remove Road E around the west end of the landfill to provide an area where additional bio-filtration swales can be constructed to treat sub-basin drainage and leachate seepage zones. (see bioswale/riparian test plot layout in Section II of this report)

2. Design sub-basin collector ditches to serve as velocity dissipation and sediment filtration systems wherever possible[4] by:

a. designing broad-bottomed swales with gently sloping sides;

b. planting swales with fine-textured vegetation capable of providing bio-filtration functions;

c. installing periodic cross-channel level spreaders which will serve to reduce flow velocities and prevent drainage ditches from becoming sources of sediments, and which will spread concentrated stormwater in a sheet flow;

3. Select vegetative treatments for erosion and sediment control and related water quality protection issues in these additional areas:

a. at stormwater discharge points;

b. in biofiltration system designs;

c. in relation to road drainage;

d. in relation to areas subject to wind erosion;

e. in areas subject to erosion caused by waves in the intertidal zone;

4. Develop the following erosion and sedimentation monitoring systems:

a. site inspections after first significant storm after planting, after the first winter, and after the first full year vegetation is established. These inspections should include:

-assessment of erosion condition factors for representative surface soil types, vegetation types, slope steepness classes, slope position and length. Erosion condition factors would include litter movement, soil movement, pedestalling, and flow patterns;

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[4] considering desired and required drainage gradient requirements.

-assessment of sedimentation condition factors at natural and man-made slope-breaks, settling basins, and other potential sediment dams. Such factors would include: depth and areal extent of aggradation, size classes of materials deposited, outflow route and fate of water flowing beyond area of aggradation;

-assessment of erosion and sediment control facilities, including materials, installation, and frequency on slope or swale.

5. Develop from the monitoring results the following prescriptions for the remainder of the landfill:

a. maximum desirable unbroken slope lengths for each slope class, soil type, and vegetative association;

b. desired frequency of water-stops and level spreaders in drainage swales and ditches;

c. desired vegetation for slope position, steepness, and length, and for drainage swales and ditches;

d. desired erosion and sediment control materials for the range of site conditions requiring "facility" versus vegetative applications.

6. Develop erosion and sediment control plan for Subarea 1 planting activities:

a. Prevent or minimize tracking of soil by project equipment from project site onto adjacent paved roads by:

-providing gravel construction entrance and exit pads;

-providing mechanical removal of soil from equipment tires before equipment leaves project site;

-limiting project activity when site soils are saturated.

b. Prevent or minimize dust pollution of adjacent areas by:

-mobilizing water tankers to spray unsurfaced project roads on which equipment will operate;

-watering down areas where excavation, stockpiling, or loading of earth materials will generate dust.

c. Prevent wind erosion of exposed earth surfaces and soil stockpiles by:

-scheduling earthwork well in advance of the mid-winter gorge winds;

-phasing earthwork and stabilization procedures so that as little disturbed ground as possible is exposed at one time to wind erosion;

-locating earth stockpiles in the lee of the expected prevailing wind.

d. Prevent or minimize stormwater detachment and transport of disturbed project soils by:

-phasing earthwork and slope stabilization activities to assure minimal exposure of disturbed earth surfaces at one time;

-field-marking drainage routes for each sub basin in which earth disturbing activities are taking place;

-field-setting temporary sediment control measures according to these drainage routes;

-providing temporary sediment control measures in all active earthwork areas so that slope lengths are never more than 50 feet.

-stockpiling appropriate erosion control materials near each active earthwork area so that the installation of erosion and sediment control materials can take place when needed during project activities;

-protecting drainage swales, ditches, sedimentation basins, and biofiltration systems from sedimentation impacts of earthwork by installing temporary sediment control measures, as specified by City of Portland, at the toe of slopes adjacent to these drainages;

-protecting these drainage features from the erosion impacts of concentrated flows by installing periodic in-channel water stops and level spreaders at intervals related to drainage gradients;

-surrounding with erosion control materials soil stockpiles which will be left overnight;

-limiting the size of soils stockpiles which will be left overnight (e.g. limit stockpile slope lengths to 20');

-developing a schedule for removal of erosion control facilities which is based on prior establishment of ground stabilizing vegetation.

7. Develop project daily procedures for inspecting, maintaining, and enhancing erosion control plans and facilities including:

-designating a point person for project erosion and sediment control who will disseminate daily erosion and sediment control plans to contractors;

-developing project protocols for mapping erosion control treatments and for conveying erosion control information to project workers.

8. Monitor the performance of a range of different erosion control practices, materials, and installations to derive erosion and sediment control prescriptions for earthwork and planting on the remainder of the landfill.

4.6.5 Closure Plan Requirements for Erosion and Sediment Control

-On slopes between 20% and 50%, installation of natural fiber erosion netting according to specifications is required.

-On slopes over 50%, cereal straw mulch and tackifier must be applied according to specifications.

4.7 TEST PLOT LANDSCAPE MAINTENANCE OVERVIEW

4.7.1 GRASSLANDS- Drought resistant native bunchgrasses and wildflowers are to be planted as mesic & xeric prairies in all test plots except those planted to the covercrop Regreen. After the expiration of the warranted period of establishment requiring a 90% cover these prairies will require minimal maintenance. A once a year high mowing first initiated in the late fall of the second full growing season is all that is needed; the mowed clipping should be left in place. Fertilization and irrigation of the prairies after the initial first year of establishment are not recommended as both practices will tend to alter the species composition by favoring exotics.

4.7.2 EMERGENTS/SHRUBS/TREES- Specifications warranting that a minimum of 80% of wetland emergent or woody materials survive at the end of the first growing season should be part of any future planting contracts. It should also be specified that during a "Period of Establishment" after planting that the planting contractor should perform monthly site inspections that include: 1) replacement of materials that are dead or missing; 2) removal of any litter or debris; and 3) completion of other measures as directed by the project manager

to reduce mortality of the plantings (e.g. waterfowl/beaver depredation). The costs for these activities should be included in the bid price for the contract. Drip irrigation of all trees and shrubs during June through September of the first growing season after fall or winter planting will insure 80% survival. Second season irrigation is optional but recommended. An efficient and economical gravity drip irrigation system could be easily setup with a tanker truck and hoses. Overhead sprinkling is not recommended. Refer to the Robert Kourik book, Drip irrigation for every landscape and all climates (cited in the Bibliography) for additional irrigation ideas. Trees and shrubs will benefit from a semi-annual fertilization with a slow release fertilizer for the first few years.

4.7.3 Pest Plant Control. The following invasive exotics should be considered noxious weeds:

Clematis spp.	(Clematis)
Convovulvus spp	(Morning Glory)
Cytisus spp.	(Brooms)
Equisetum arvense	(Field Horsetail)
Lythrum salicaria	(Purple Loosestrife)
Myriophyllym spicatum	(Eurasian Millfoil)
Phalaris arundinacea	(Reed Canary Grass)
Rubus discolor	(Himalaya Blackberry)
Solanum spp	(Nightshades)

A long term pest plant control program should be designed and put in place at the St. Johns Landfill. This program should: identify pest plants by photo or live speciman; suggest methods of cultural, mechanical and/or chemical control; provide for staff training.

4.8 TEST PLOT MONITORING PLAN

4.8.1 Methodology and Evaluative Criteria

It is critical to document the methods of soil preparation and the materials and methods of planting so that the site can be monitored to assess the effectiveness of various techniques and therefore the cost-effectiveness of these techniques.

For vegetation monitoring, 200' long line transects should be established. Along these line transects, the occurrence of species, the canopy length represented by the species, and the height of the plants, should be measured at the time of peak biomass. There should be two or more measurements made of those plots for areas which contain species which differ in their time of peak biomass.

At least 12 of these line transects should be established immediately after planting, and retained as permanent transects. There should be at least three transects in each of the major treatment types: mesic prairie, xeric prairie, and lowland shrubs, bioswales, forested wetland, plus riparian woodland.

4.8.2 Wildlife Monitoring

Wildlife use of the covered landfill will need to be monitored to assess species diversity, significant habitat features, and to determine the potential for certain species to damage the cover geomembrane. Early morning walking transects should be undertaken two or three times in each season. Birds observed and heard, and the habitat they were heard or observed in should be recorded. Mammal species and/or species sign, such as tracks, scat, runways and mounds should also be recorded.

A live trapping program for small mammals and amphibians can be implemented annually to quantify species diversity and abundance. Methods can be modeled after the Smith and Bybee Lakes Biomonitoring Program.

Existing literature on landfill closure indicates that burrowing mammals do not present a problem to geomembrane integrity. The SJL Subarea 1 could be used to collect site-specific information on burrowing animal activity. Burrows constructed by different mammal species can be carefully excavated to determine burrowing depth and the behavior of burrowers relative to sand and geofabric/ geomembrane layers.

5 ESTIMATED BUDGET FOR SUBAREA 1 TEST PLOT SETUP

5.1 PROPOSED PLANT MATERIAL FOR SUBAREA TEST PLOTS: TOTAL ESTIMATED BUDGET FOR VEGETATION ACQUISITION

TOTAL COST OF 12 ACRE COVERCROP TEST PLOT MATERIALS:	$ 480.00
TOTAL COST OF 4.5 ACRE XERIC PRAIRIE MATERIALS:	2,320.50
TOTAL COST OF 4 ACRE MESIC PRAIRIE MATERIALS:	1,557.00
TOTAL COST OF SHRUB TEST PLOT PLANT MATERIALS:	504.00
TOTAL COST OF BIOSWALE TEST PLOT PLANT MATERIALS:	3,000.00
TOTAL COST OF FORESTED WETLAND TEST PLOT MATERIALS:	1,615.00
TOTAL COST OF RIPARIAN WOODLAND TEST PLOT MATERIALS:	2,150.00
TOTAL ESTIMATED COST OF SUBAREA 1 TEST PLOT PLANT MATERIALS:	**$ 14,626.50**

5.2 PROPOSED PLANT MATERIAL: ITEMIZED BUDGET FOR PLANT MATERIALS NEEDED FOR TEST PLOT SETUP

NOTE:All plants and seed except as noted are available as of July 9, 1992; however, availability and prices quoted below are subject to change without notice. Normally, a minimum of 6 months advance notice and downpayment on order is recommended.

SPECIES	SEEDING RATE	COST/POUND	COST/TOTAL AREA
Covercrop Test Plots:	**12 acres total area**		
"Regreen" Covercrop	25 lb/acre	1.60	480.00
Xeric Prairie Test Plots:	**4.5 acres total area**		
Festuca idahoensis	8 lb/acre	15.00	540.00
Poa sandbergii	2 lb/acre	24.00	216.00
Sitanion hystrix	2 lb/acre	24.00	216.00
Stipa comata	1 lb/acre	33.00	148.50
Covercrop-Regreen	10 lb/acre	1.60	72.00
*Balsamorhiza sagittata**	1/2 lb/acre	50.00	112.50
*Eriogonum umbellatum**	1/2 lb/acre	87.00	43.50
Lupinus sericeus	3 lb/acre	72.00	972.00
Mesic Prairie Test Plots:	**4 acres total area**		
Bromus carinatus	2 lb/acre	15.00	120.00
Elymus glaucus	6 lb/acre	10.00	240.00
Festuca idahoensis	6 lb/acre	15.00	360.00
Festuca rubra v. rubra	4 lb/acre	18.00	288.00
Covercrop-Regreen	8 lb/acre	1.60	51.00
*Achillea millefolium**	1 oz/acre	75.00	16.00
*Aster chilensis**	2 oz/acre	74.00	32.00
*Eriophyllum lanatum**	1 oz/acre	50.00	12.00
*Eschscholzia californica**	4 oz/acre	10.50	(minimum) 10.00
Lupinus bicolor	2 lb/acre	33.00	264.00
Lupinus polyphyllus	2 lb/acre	19.00	152.00
*Solidago canadensis**	4 oz/acre	60.00	12.00

* = optional plants

SPECIES	PLANT SPACING	COST EACH
Upland-Lowland Shrub Test Plots	**3 - 250 ft transcets**	
Rose nutkana	1 per 3 sq ft	3.00
Synphoricarpos albus	"	3.00
Amelanchier alnifolia	"	3.00
Salix scouleriana	"	3.00
Bioswale Test Plot:	**6,000 sq ft total area**	
Beckmannia syzigachne	Contract grow	(sq ft) .50
Descahmpsia caespitosa	"	same
Eleocharis palustris	"	same
Festuca rubra v. rubra	"	same
Juncus tenuis	"	same
Juncus effusus	"	same
Forested Wetland Test Plot	**1,900 sq ft total area**	
OVERSTORY	PLANT SPACING	
Crataegus douglasii	30 ft o.c.	9.50
Fraxinus latifolia	groups of 3-5/40 ft. o.c.	6.00
Rhamnus purshiana	30 ft o.c.	8.00
Rosa nutkana	groups of 3-7/20 ft. o.c.	5.00
Salix scouleriana	groups of 1-3/20 ft. o.c.	3.50
Sambucus racemosa	40 ft. o.c.	6.00
Symphoricarpos albus	groups of 1-5/20 ft. o.c.	3.50
GROUNDLAYER	SEEDING RATE	COST/POUND OR EACH
Beckmannia syzigachne	6 lb/acre	15.00
Deschampsia caespitosa	2 lb/acre	25.00
Eleocharis palustris	1 plug/3 sq ft	(each) .75
Festuca rubra v. rubra	4 lb/acre	18.00
Juncus tenuis	1 plug/3 sq ft	(each) .75
Juncus effusus	1 plug/3 sq ft	(each) .75
Covercrop-Regreen	12 lb/acre	1.60

SPECIES	PLANT SPACING	COST EACH
Riparian Woodland Test Plot	**1800 sq ft**	
OVERSTORY		
Acer macrophyllum	50 ft. o.c.	11.00
Alnus rubra	groups of 1-5/40 ft o.c.	6.00
Populus trichocarpa	30 ft o.c.	11.00
Salix lasiandra	40 ft o.c.	8.50
Salix sitchensis	groups of 1-3/30 ft o.c.	8.50
Salix scouleriana	30 ft. o.c.	8.50
		9.50
UNDERSTORY		
Amelanchier alnifolia	10 ft o.c.	
Cornus stolonifera	groups of 1-7/20 ft o.c.	7.50
Lonicera involucrata	30 ft o.c.	4.50
Rhamnus purshiana	30 ft o.c.	8.00
Rosa nutkana	groups of 3-7/20 ft o.c.	3.50
Sambucus cerulea	40 ft o.c.	3.50
Sambucus racemosa	20 ft o.c.	6.00
Symphoricarpos albus	groups of 1-5/20 ft o.c.	3.50
EDGE/GROUNDLAYER	SEEDING RATE	COST/LB. OR OZ.
Elymus glauca	10 lb/acre	(lb) 10.00
Covercrop-Regreen	10 lb/acre	(lb) 1.60
Epilobium angustifolium	6 oz/acre	(oz) 7.50

APPENDIX

1. BIBLIOGRAPHY
2. ST. JOHNS LANDFILL CONSTRUCTION DOCUMENTS
3. LANDFILL OR SUPERFUND PROJECTS/CONTACTS
4. GEOGRAPHIC DISTRIBUTION WITHIN OREGON OF POTENTIAL REVEG PLANTS FOR CAPPED PORTION OF LANDFILL
5. DRAFT REPORT COMMENTS: LARRY BOERSMA
6. LAND IMPRINTING FOR VEGETATIVE RESTORATION

BIBLIOGRAPHY

Andropogon Associates, Project Director: Leslie Sauer; Project Manager: Clare Billett. February 1991. Cover Vegetation Program Fresh Kills Landfill, Staten Island NY. Submitted as section 3.4 of the NYSDEC Consent Order requirement report Appendix A3: Draft Final Cover Report.

CH2M-Hill. Mike Kennedy. 1980. Contract Documents for Operation of the St. Johns Sanitary Landfill. METRO.

Chang, G.Y.S., M.H. Wong, and B.A. Whitton. 1991. Effects of Landfill Gas on Subtropical Woody Plants. *Environmental Management*. Vol. 15, No. 3, pp 441-431. Springer-Verlag New York, Inc.

Cohen, Tracy. 1992. Trends - "Ecological Restoration" *Technology Review*. February/March 1992. pages 20, 21.

Cornforth Consultants, Sept 1991. Parts of drawing titled "Site Plan/Seep Locations". (Shows Sub 1, 2, 3 seep locations)

DEQ Lab Report - Leachate Sump sampled 11/16/89.

DEQ Pages 3 & 4 from April 15, 1991 letter from Joe Ginyorich to Dennis O'Neil re: subsoil/topsoil/vegetation combination.

Emery, 1988. Seed Propagation of Native California Plants, Santa Barbara Botanic Garden.

Feeney, Michael T. 1990. Geosynthetics in Landfill Closures Design Considerations. Proc. of 4th GRI Seminar on Landfill Closures; Dec. 13 & 14, 1990; Drexel Univ; Philadelphia, PA.

Fishman Environmental Services with Mark G. Wilson, Horticulturist and Mike Faha and Associates, Landscape Architects. April 1992. St. Johns Landfill Cover Vegetation Plan.

Franklin & Dyrness: 1988. Natural Vegetation of Oregon & Washington, OSU Press.

Gilkey & Dennis: 1980. A Handbook of Northwestern Plants, OSU Press.

Gordon, Sean. October 1991. Tree Planting on Landfills. *BioCycle* (October 1991). p. 80.

Hartmann & Kester, 1975. Plant Propagation: Principles & Practices, Prentice-Hall.(revised edition available)

Hitchkock & Cronquest: 1987. Flora of the Pacific Northwest (single volume edition), U of Washington Press.

Jolley: 1988 Wildflowers of the Columbia Gorge, OR Historical Society Press.

Kourik, Robert: 1992. Drip Irrigation for Every Landscape and All Climates. Metamorphic Press.

Landreth, Robert E. 1991. The Resistance of Membranes in Cover Systems to Root Penetration by Grass and Trees. EPA. Geosynthetics '91 Conference. Atlanta, GA.

Licht, Louis A.; Jerald L. Schnoor; and Mark F. Madison. June 1991. Impact of Poplar Tree Buffers on Riparian Ecosystems. American Society of Agricultural Engineers, Paper No. 912136, an ASAE Meeting Presentation.

Mathews: 1988. Cascade-Olympic Natural History, Raven Editions & Portland Audubon.

Memo - Surface Water Sampling in North Slough test results from seep samples dated 08/08/88.

METRO. 1992. Storm Water Pollution Control Plan for a General Storm Water Discharge Permit for the St. Johns Landfill. METRO. Solid Waste Division. Request for Proposals. RFP # 92R-14-SW.

METRO. April 1992. St. Johns Landfill Closure of Subarea 1 Contract Documents. Metropolitan Service District.

METRO. March 1992. Request for Proposals for Development of a Vegetation Plan for the St. Johns Landfill. Metropolitan Service District.

METRO. December, 1991. St. Johns Landfill Closure of Subarea 1. Drawings in an 11" x 17" format. Metropolitan Service District. DWG No. 1919031. 30 pages.

METRO. June 1989. A Users Guide to Yard Debris Compost. Metropolitan Service District.

Moffat, A.J. and T.J. Houston. 1991. Tree Establishment and Growth at Pitsea Landfill Site, Essex, U.K. (Based on a report in *Seesoil* (1987), 4, 66-83). *Waste Management & Research* (1991) 9, 35-46.

The Nature Conservancy: Selected Oregon Preserve inventory data

O'Neil, Dennis, letter to Pam Murphy dated April 24, 1991; Re: Tree Planting Experiment.

Peck: 1961. A Manual of the Higher Plants of Oregon, Binfords & Mort.

Richardson, Gregory N. and Robert M. Koerner. Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments. US EPA. Hazardous Waste Engineering Research Laboratory. Contract No. 68-03-3338.

Robinson, George R., Steven N. Handel, and Victoria R. Schmalhofer. 1992. Survival, Reproduction, and Recruitment of Woody Plants After 14 Years on a Reforested Landfill. *Environmental Management*. Vol. 16, No. 2, pp 265-271. © 1992 Springer-Verlag New York Inc.

Robinson, George R., and Steven N. Handel. Restoring a Coastal Forest Community: Rapid Dispersal of Woody Plants into an Experimental Plantation. Submitted to: *Conservation Biology*.

Shimell, Pamela. 1983. Landfill: Plant Life REstores Waste Disposal Sites. *World Wastes*.

U.S.D.A.-US Forest Service, January, 1976. Plant Communities of the Central Oregon Pumice Zone.

U.S.D.A., Forest Service, 1974. Seeds of Woody Plants of the United States, Agriculture Handbook #450, US Government Printing Office.

Wiedeman, Dennis & Smith: 1982. Plants of the Oregon Coastal Dunes, OSU Press.

Wilson, Mark G.: Selected Western OR native grassland inventory data

Young & Young, 1986. Seeds of Wildland Plants, Timber Press.

St. Johns Landfill

CONSTRUCTION DOCUMENTS FOR
SUBAREA (1) SITE PREPARATION AND SEEDING

Prepared for:

Metropolitan Service District
Solid Waste Department

Prepared by:

Fishman Environmental Services with
Mark Wilson, Horticulturist
Mike Faha and Associates, Landscape Architects
Wes Jarrel, Ph.d

August 1992

ADDENDUM TO SUBAREA 1 ST. JOHNS LANDFILL COVER VEGETATION PLAN
CONSTRUCTION DOCUMENTS (Submitted August, 1992)

SEPTEMBER 2, 1992

TECHNICAL SPECIFICATIONS:

Page 02930-5 /Paragraph 3.04

Delete existing language /Substitute the following:

3.04 Seeding

A. Seed all areas on plan not specified for dual stage hydroseeding or broadcast/track seeding with a grain drill type seeder.

B. Sow seed at the rates specified in paragraph 2.01B.

C. Seed shall be uniformly distributed over designated areas. Apply seed with a cereal grain drill at 1-2" below surface of moist soil. If planting in dry soil, seed should be planted at a 2-3" depth.

Page 02930-6 /Paragraph 3.06 WARRANTY AND MAINTENANCE

Delete existing subparagraph A./Substitute the following:

3.06 WARRANTY AND MAINTENANCE

A. The contractor shall guarantee a satisfactory stand in all Subarea 1 areas seeded with field grass mixtures. A satisfactory stand is defined as: ...

CONSTRUCTION DRAWINGS

Delete existing NOTES /Substitute the following:

NOTES

1. All Regreen areas shall be seeded with a grain drill seeder.

2. All seeded areas not specified for broadcast/track seeding or dual stage hydroseeding (see drawing notes above) shall be seeded with a grain drill seeder.

TABLE OF CONTENTS

1. GENERAL

A. LIST OF ARTICLE TITLES

1.01 DESCRIPTION OF WORK
1.02 SEQUENCING PLAN

1.01 DESCRIPTION OF WORK

A. The work covered by this contract includes furnishing of labor, materials and equipment for construction of the following:

1. St. Johns Landfill Subarea 1: Ground surface preparation, slope stabilization log placement and seeding.

1.02 SEQUENCING PLAN

A. Before starting work, submit to the Engineer a proposed construction schedule showing the proposed order of work and indicate the time required for completion of the major items of work. The schedule shall be realistic and definitive as to the amount of work which is to be accomplished within the time indicated and shall be updated weekly to reflect actual work progress. In the event that the proposed schedule does not meet the criteria as set forth herein as determined by the Engineer, resubmit until the criteria is met. Working schedules shall be used as an indication of the sequence of the major construction operations and as a check on the progress of the work and may, at the sole discretion of the Engineer, be employed by the Engineer in determining delays and time extensions, but does not become a part of the Contract.

B. Contractor will make no changes in the schedule of the work unless, to the extent possible, he provides two (2) weeks advance notice to the Engineer or secures the Engineer's approval prior to performing such changes.

C. Engineer's review of original schedule shall not constitute a warranty or representation by Owner that Contractor can perform the work according to such schedule.

D. The Contractor shall schedule construction activities to conform to the following general requirements:

August 1992:

1. * Order specified seed and submit downpayment to vendors. Request delivery no later than 9/1/92. Submit seed invoices or source verification to project manager.
2. * Place old stripped temporary cover soil on top of sand layer in all areas of Subarea 1 as specified by FES.**
3. * Complete FES specified placement and grading of imported soil on all areas of Subarea 1.**
4. Submit soil samples to project manager for nutrient analysis.
5. Incorporate compost in top 4" of final cover soil/Disc to mix.

September 1992:

1. Add fertilizers as specified/Disc top 4" of soil.
2. Prepare seedbeds in all areas of Subarea 1 with disc and harrow.
3. Layout test plots as specified.

September 20 - October 10, 1992:

1. Seed all test plots as specified using the following equipment and methods: Broadcast seed / track, double stage hydroseeding and brillion seeding (see plan for method).
2. Place slope stabilization logs in test plots then seed erosion control test plot areas using double stage hydroseeding method.
3. Seed FES specified Regreen cover crop on remainder of Subarea 1 areas using a brillion seeder.
4. * Implement erosion control specifications.

October 1992 - February 15, 1993 (weather dependent)

1. Monitor vegetation a minimum of once monthly / Repair erosion and or reseed with cover crop as necessary.

February 15 - March 15 (weather dependent)

1. Reseed all areas as necessary to meet warranty. Follow initial seeding specifications.

* Not in this contract (included for reference and coordination).

** Refers to St. Johns Landfill Cover Vegetation Plan report by Fishman Environmental Services (FES).

End of Section

SECTION 02920
SITE PREPARATION

1. GENERAL

A. LIST OF ARTICLE TITLES

1.01 DESCRIPTION OF WORK

A. The work covered in this section consists of furnishing all labor, materials and equipment for preparation of soil as shown on the drawings and as specified.

1.02 RELATED SECTIONS

A. Section 02930 - Seeding

1.03 QUALIFICATIONS

A. All soil preparation work shall be done under the supervision of a Contractor having experience in landscape construction. All work shall be done in accordance with good horticultural practices.

1.04 SUBMITTALS

A. Submit sample of compost for acceptance.

B. Submit guaranteed analysis of fertilizer mixes.

1.05 PRODUCT DELIVERY AND STORAGE

A. Store fertilizer in a dry place and protect from intrusion of moisture.

1.06 SEQUENCING AND SCHEDULE

A. See sequencing plan (Section 01010)

1.07 ENVIRONMENTAL CONDITIONS

A. Prepare soil only when topsoil is not in a wet or muddy condition. Take all precautions to prevent runoff of topsoil and fertilizers.

1.08 PROTECTION

A. Provide protective cover and barriers as necessary to prevent damage and staining to all site improvements and of site structures, trees, facilities and property.

1.09 HERBICIDE APPLICATION QUALIFICATION

A. No herbicide shall be used on this project.

1.10 SOILS TESTING

A. Send five representative soil samples to an approved soil testing laboratory for complete analysis and fertilizer / amendment recommendations. Results shall be sent to Owner's Representative.

B. Obtain approval of soil sample locations from the Owner's Representative and provide flagging / markers that shall remain throughout construction.

1.11 FIELD QUALITY CONTROL

A. Finish grading: Inspected and approved by the Owner's Representative prior to seeding operations.

2. PRODUCTS

2.01 TOPSOIL

A. Topsoil shall be existing topsoil in place.

2.02 COMMERCIAL FERTILIZER

A. Commercial fertilizer shall be approved brands conforming to applicable state fertilizer laws, uniform in composition, dry, free flowing, delivered to the site in original unopened containers, each bearing the manufacturer's guaranteed analysis.

B. Nurtrient analysis and application rate shall be determined by Owner's Representative based on soil analysis.

2.03 COMPOST

A. "Garden Care" sludge compost, available from North American Soils, Inc. 5303 N. Columbia Boulevard, Portland, Oregon.

2.04 WATER

A. Water shall be suitable for irrigation, free from oil, acid, alkali, salt or other substances harmful to plant life.

3. EXECUTION

3.01 INSPECTION

A. Flag each test plot area with temporary markers for approval by Owner's Representative.

B. Examine the entire site for conditions that will adversely affect execution, permanence and quality of work, and survival of plant materials, and grass.

C. Verify that rough grades and slopes of areas to be seeded and planting areas are correct prior to commencing work of this section. If the site is not suitable for seeding operations, the Contractor shall perform necessary corrective work.

3.02 GENERAL PREPARATION OF GROUND SURFACES

A. Eliminate uneven areas and low spots, remove lumber, stones, sticks, mortar, concrete, rubbish, debris, contaminated soil and any material harmful to plant life, in areas to be seeded.

B. Eliminate existing grasses by disking the soil to a depth of four (4) inches where they occur.

3.03 SOIL PREPARATION FOR SEEDED FIELDGRASS AREAS

A. Apply three (3) inches of compost to all areas to be seeded.

B. Apply fertilizer at rates recommended by Owner's representative

C. Disk the compost and fertilizer into the top four (4) inches of soil. Make as many passes with the equipment as necessary to thoroughly blend the compost with the soil. The disking shall continue until clod size is less than one inch in diameter. Final disking shall be with the contour of the slope.

D. Immediately before seeding, harrow and rake, to remove stones, clods, sticks, and other foreign matter larger than 1-inch in largest dimension from top 1-inch of soil; establish smooth, fine textured seed bed.

3.04 CLEANUP

A. Keep project site reasonable free from accumulation of debris, top-soil, other material.

B. At completion of each area of work, remove debris, equipment and surplus materials.

C. Any paved area or surfaces stained or soiled from landscaping materials shall be cleaned with a power sweeper using water under pressure.

End of Section

SECTION 02925
SLOPE STABILIZATION
LOG PLACEMENT

1. GENERAL

A. LIST OF ARTICLE TITLES

1.01 DESCRIPTION OF WORK

A. The work covered in this section consists of furnishing all labor, materials and equipment for placement of slope stabilization logs as shown on the drawings and as specified.

1.02 RELATED SECTIONS

A. Section 02920 - Site preperation

1.03 SUBMITTALS

A. Provide copy of log purchase order from source to Engineer.

1.04 PRODUCT DELIVERY AND STORAGE

A. Store logs in area designated by Engineer.

1.05 SEQUENCING AND SCHEDULE

A. See sequencing plan (Section 01010)

1.06 ENVIRONMENTAL CONDITIONS

A. Place logs only when topsoil is not in a frozen or muddy condition.

2. PRODUCTS

2.01 LOGS

A. The contractor shall provide forty logs for slope stabilization.

B. Logs shall be utility grade Douglas Fir. Burn marks are allowable.

C. The length of the logs shall be a a minimum of 26' and a maximum of 30'.

D. The diameter of the logs shall be between 24" and 40".

E. Logs are available from Weyerhauser-Longview (Bob Bishop at 206-425-2150)

3. EXECUTION

3.01 INSPECTION

A. Flag each test plot area with temporary markers for approval by Owner's Representative.

B. Examine the entire site for conditions that will adversely affect execution, permanence and quality of work.

C. Verify that rough grades and slopes of areas are correct prior to commencing work of this section. If the site is not suitable for log placement operations, contact the Engineer.

3.02 LOG PLACEMENT

A. The Engineer shall stake the location of the logs.

B. Logs shall be placed parallel with the slope contour.

C. Logs shall be firmly embedded into the ground surface. All logs shall be placed one third (1/3) of their diameter into the ground. Redistribute excavated material at base of log to anchor log in place.

End of Section

SECTION 02930
SEEDING

1. GENERAL

A. LIST OF ARTICLE TITLES

1.01 DESCRIPTION OF WORK

A. Work consists of providing all labor, material and equipment for installing field grass as indicated below.

1. Plant and establish field grass mixture as shown on drawings.

1.02 RELATED SECTIONS

A. Section 02920 - Topsoil Placement and Soil Preparation

1.03 QUALIFICATIONS

A. Work performed as described in this section shall be done under the supervision of a contractor having experience in landscape construction.

1.04 REFERENCE STANDARDS

A. United States Department of Agriculture (USDA).

1.05 SUBMITTALS

A. Guaranteed analysis of field grass seed mixture.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure seed, percentage of weed and crop seed, year of production, net weight, date of packaging and location of packaging. Damaged packages are not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.07 JOB CONDITIONS

A. See sequencing plan (Section 01010)

B. Weather conditions: Seeding is not permitted during the following conditions:

1. Cold weather: When air or ground temperature is less than 32 degrees F.

2. Hot weather: When air temperature is greater than 90 degrees F.

3. Wet weather: when ground becomes saturated.

4. Windy weather: When wind velocity is greater than 30 mph.

2. PRODUCTS

2.01 SEED MIXTURE

A. General

1. Seed species shall be provided by Owner.

2. Contractor shall be responsible for mixing seed.

B. Application rates

	SPECIES	SEEDING RATE
1.	Covercrop Test Plots	12 acres total area
	"Regreen" Covercrop	25 lb/acre
2.	Xeric Prairie Test Plots:	4.5 Acres total area
	Festuca idahoensis	8 lb/ac
	Poa sandbergii	2 lb/ac
	Sitanion hystrix	2 lb/ac
	Stipa comata	1 lb/ac
	Covercrop-Regreen	10 lb/ac
	Balsomarhiza sagittata	1/2 lb/ac
	Eriogonum umbellatum	1/2 lb/ac
	Lupinus sericeus	3 lb/ac
3.	Mesic Prairie Test Plots:	4 acres total area
	Bromus carinatus	2 lb/ac
	Elymus glaucus	6 lb/ac
	Festuca idahoensis	6 lb/ac
	Festuca rubra v. rubra	4 lb/ac
	Covercrop-Regreen	8 lb/ac
	Achillea millefolium	1 oz/ac
	Aster chilensis	2 oz/ac
	Eriophyllum lanatum	1 oz/ac
	Eschscholzia californica	4 oz/ac
	Lupinus bicolor	2 lb/ac
	Lupinus polyphyllus	2 lb/ac
	Solidago canadensis	4 oz/ac

2.02 WATER

A. Water shall be free from oil, acid, alkali, salt and other substances harmful to growth of grass, and shall be from a source approved prior to use.

2.03 WOOD-CELLULOSE FIBER MULCH

A. Wood-cellulose fiber mulch for use with the hydraulic application of grass seed and fertilizer shall consist of specially prepared wood-cellulose fiber processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of application of materials. The mulch material shall be supplied in packages having a gross weight not in excess of 100 pounds. The woodcellulose fiber shall contain not in excess of 10% moisture, air-dry weight basis. The wood-cellulose fiber shall be manufactured so that after addition and agitation in slurry tanks with fertilizers, grass seeds, water and any other ap-

proved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry and that when hydraulically sprayed on the ground, the material will form a blotter-like ground cover impregnated uniformly with grass seed and which, after application, will allow the absorption of moisture and allow rainfall or mechanical watering to percolate to the underlying soil. Suppliers shall be prepared to certify that laboratory and field-testing of their product has been accomplished and that their product meets all of the foregoing requirements based upon such testing.

2.04 SOIL STABILIZER

A. Soil stabilizer shall be capable of penetrating soil surface and binding soil particles; shall provide an adhesive to hold seed and wood-cellulose fibers together and bond them to the soil; and shall be made from naturally occurring and biodegradable materials, such as "aquatain" or equal.

2.05 SPECIAL SEEDING AND MULCHING EQUIPMENT

A. Hydraulic equipment used for the application of fertilizer, seed and slurry of prepared wood-cellulose fiber shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend and homogeneously mix the slurry specified. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of spray nozzles that will provide even distribution of the slurry on the various slopes.

3. EXECUTION

3.01 PREPARATION

A. Verify that grading has been completed correctly.

1. Notify Engineer of any discrepancies; do not proceed with work until discrepancies have been resolved.

B. Notify Engineer at least 24 hours prior to planting or seeding operations. Engineer will inspect soil preparation and finish grading.

3.02 DUAL STAGE HYDROSEEDING

A. See plan for areas designated for this method of seeding.

B. Seed shall be broadcast with approved hydraulic seeding equipment, in combination with wood-cellulose fiber mulch, soil stabilizer and fertilizer, as specified herein at the rate specified in Paragraph 2.01B. Seed shall be distributed uniformly over designated areas. Half of seed shall be sown with sower moving

in one direction, and the remainder with sower moving at right angles to first sowing. Seed shall not be broadcast during windy weather. The wood-cellulose fiber shall be applied at the ate of 2000 pounds per acre. The soil stabilizer shall e applied at the rate of 60 pounds per acre minimum on slopes greater than 30% and 50 pounds per acre minimum on slopes less than 30%. Agitate slurry mix periodically as necessary to insure an even mix of ingredients. When area to be seeded adjoins a structure, care shall be taken not to apply seed to structure. Any seed so applied shall be removed before soil stabilizer sets.

C. Clean slurry tank and all hoses off site before loading grass/wildflower mix. Insure that no other type of seeds are present in the application equipment.

D. Hydroseed all areas in a two stage process: First apply all seed and 10% of the mulch, secondly; track over seed/mulch with a cat or similarly cleated machinery parallel with slope contours, thirdly; apply the remaining 90% of the mulch over the top of the initial application.

3.03 BROADCAST / TRACK SEEDING

A. See plan for areas designated for this method of seeding.

B. Sow seed at the rate specified in paragraph 2.01 B.

C. Seed broadcasting shall be done with a hand seeder able to be calibrated for sowing very small wildflower seed, such as a Cyclone seeder.

D. Seed shall be uniformly distributed over designated areas. Divide seed in equal parts, apply one half in north-south direction and the other half in east-west direction.

E. Track over seed with a cat or similarly cleated heavy equipment, cleat marks shall be parallel with the slope contours.

3.04 BRILLION SEEDING

A. Seeding with a brillion seeder applies to all seeded areas on plan not specified for dual stage hydroseeding or broadcast/track seeding.

B. Sow seed at the rate specified in paragraph 2.01 B.

C. Seed shall be uniformly distributed over designated areas. Apply seed using notched roller-type brillion seeder, placing seed in top one half inch of soil.

3.05 PERMANENT MARKING

A. The contractor shall provide permanent markers that deliniate the test plots.

B. Markers shall be either wood or plastic, height shall be 36" above finish grade.

C. Markers shall be placed at 50' intervals along all test plot boundries and all corners.

D. Markers shall be labled permanently per Engineer's direction.

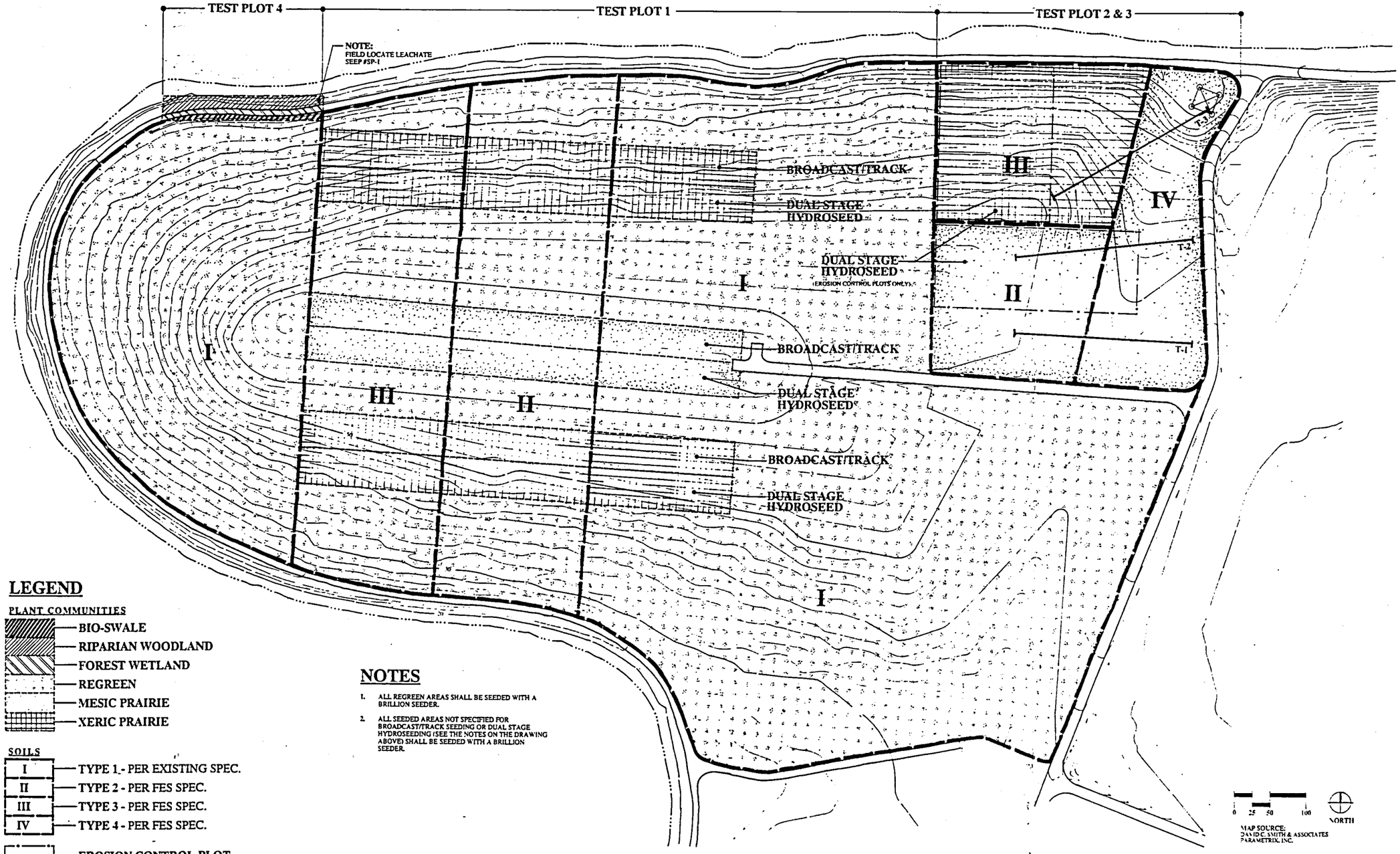
3.06 WARRANTY AND MAINTENANCE

A. The contractor shall guarantee a satisfactory stand of the hydroseeded groundlayer. A satisfactory stand is defined as:

1. Ninety percent or more of the ground covered with grasses and wildflowers.
2. No bare spots larger than six inches square.

The contractor shall reseed all areas that do not meet these requirements between February 15 and March 15, 1993. Reseeding shall meet the original specifications.

End of Section



LEGEND

PLANT COMMUNITIES

- BIO-SWALE
- RIPARIAN WOODLAND
- FOREST WETLAND
- REGREEN
- MESIC PRAIRIE
- XERIC PRAIRIE

SOILS

- I — TYPE 1 - PER EXISTING SPEC.
- II — TYPE 2 - PER FES SPEC.
- III — TYPE 3 - PER FES SPEC.
- IV — TYPE 4 - PER FES SPEC.

- EROSION CONTROL PLOT (PLACE LOGS ON HALF OF PLOT)
- TEST PLOTS (TRANSECTS)
  - T-1 — ROSA NUTKANA, SYMPHORICARPOS ALBUS
  - T-2 — AMELANCHIER ALNIFOLIA, SALIX SCOULERIANA
  - T-3 — AMELANCHIER ALNIFOLIA, SALIX SCOULERIANA

NOTES

1. ALL REGREEN AREAS SHALL BE SEEDED WITH A BRILLION SEEDER.
2. ALL SEEDED AREAS NOT SPECIFIED FOR BROADCAST/TRACK SEEDING OR DUAL STAGE HYDROSEEDING (SEE THE NOTES ON THE DRAWING ABOVE) SHALL BE SEEDED WITH A BRILLION SEEDER.

METROPOLITAN SERVICE DISTRICT
SOLID WASTE DEPARTMENT

FISHMAN ENVIRONMENTAL SERVICES

MARK G. WILSON - HORTICULTURIST • WES JARRELL • MIKE FAHA & ASSOCIATES - LANDSCAPE ARCHITECTS

SUBAREA 1 TEST PLOT PLAN

ST. JOHNS LANDFILL COVER VEGETATION PLAN

LANDFILL or SUPERFUND PROJECTS/CONTACTS (May & June 1992)

California

Byxbee Park, (former landfill) S.F., CA
info: Rick Thiel-EMCON & Peter Gereghty @ Hargreaves & Assoc. (415) 543 4957
magazine article & additional info available from MGW
clay cap; native grass cover

LA County Sanitation District
info: Phil Ackman (310) 699 7411 ext. 2106
geomembrane cover; non-native grass cover

Lake County (mine reclamation)
info: Gail Newton (916) 323 8564 and (707) 263 2221
vegetation cover failure

North Berkeley Waterfront Park (former landfill), Berkeley, CA
info: David Kaplow (707) 769 1213
report and additional info available from MGW
clay cap; native grass and woody plant cover

San Benito County Superfund Site
info: Gayle Newton (916) 323 8564
& Tim Moore, BLM, Hollister, CA
geomembrane cover; problems w/vegetation cover

Sunnyvale Landfill Natural Landscape, Sunnyvale, CA
info: David Kaplow (707) 769 1213
report and additional info available from MGW
clay cap; native & non-native grass and woody plant cover

Sunshine Canyon Landfill L.A.; CA
info: Brian McRae (213) 485 6556
geomembrane cover; maintenance problems w/non-native grass cover

Washington

King County Landfill
info: Dave Nyblumg (206) 296 6542
geomembrane & clay cap cover; problems w/non-native grass cover
Lichner Landfill, Vancouver
info: Rick Thiel EMCON

Elsewhere

Fresh Kills, NY, NY
info: Project Design & Revegetation Project Manager for NY
Department of Sanitation:
Bill Young (718) 356 0203
Revegetation Design Consultant:
Leslie Sauer/Andropogon, LTD. (215) 487 0700
Vegetation Monitoring Consultant:
Steve Handel, Rutgers/Cook College
(908) 932 5341
reports, magazine articles & other info available from FES/MGW
geomembrane & clay cap; primarily native grass, wetland, and woody plant cover

Cleveland Landfill, OH
info: Project Designer for City of Cleveland:
Judith Bargo (216) 664 3284
clay cap; primarily native plant cover

Dyer Landfill, FL
info: Design & Vegetation Consultant:
George Gentile, Jupiter, FL (407) 575 9557
article & other info available from MGW
geomembrane & clay cap; primarily native grass, wetland & woody plant cover

Emerald Park Landfill, Madison, WI
info: Bob Gleebs or Todd Watermullin/Creative Resource Ventures/(608) 276 6082
Revegetation Consultant: Steve Apfelbaum (608) 897 8641
additional information available from MGW
geomembrane cap; native grass & woody plant cover

North Vancouver, BC Landfill CANADA
info: Harry McBride (604) 299 7100
Dirk Oostindie (604) 986 9141
reports & other info available from MGW
clay cap; primarily native grass & woody plant cover
SWANCC Facility (proposal), IL
info: Victoria Nuzzo (815) 637 6622 or MGW
geomembrane & clay cap; native grass, wetland, and woody plant cover

GEOGRAPHIC DISTRIBUTION WITHIN OREGON OF POTENTIAL REVEG PLANTS FOR CAPPED PORTION OF LANDFILL

NOTE-The following list is very generalized and specific only to broad regions of Oregon. The list was composed from a search of the literature noted in the REFERENCES. For explanations of the abbreviations used see the GEOGRAPHIC CODES section.

SHRUBS

Amelanchier alnifolia (Serviceberry)

Ubiquitous: W. OR- Interior valleys; SW. OR- Siskiyou Mts.; E. OR-Blue Mts.; E. OR & WA- Columbia Basin riparian comm.

Arctostaphyllos columbiana (Hairy Manzanita)

N. OR Coast- Strand/Sand dune comm.

Arctostaphyllos uva-ursi (Kinickinick)

Ubiquitous: W. WA- Puget Sound; OR Coast- Strand/Sand dune comm.; OR West & High Cascades- Subalpine comm. & Alpine comm.; SW OR & NW/C WA- Serpentine outcrops

Corylus cornuta (Hazel)

W. OR- Coast Range, Interior Valleys, West Cascades; S. OR- Siskiyou Mts. (west)

Crataegus douglasii (OR Hawthorne)

Ubiquitous: W. OR- Interior Valleys, Columbia Gorge; E. OR & WA- Columbia Basin riparian comm.

Myrica californica (CA Myrtle)

N. OR Coast- Strand/Sand dune comm.

Philadelphus lewisii (Mock Orange)

Ubiquitous: W. OR- Interior Valleys, Columbia Gorge; S. OR- Siskiyou Mts. (west); E. OR & WA- Columbia Basin, Mixed species forests

Pinus contorta spp. (Shore & Lodgepole Pine)

Shore Pine-
OR Coast- Strand/Sand dune comm.
Lodgepole Pine-
W. OR- Columbia Gorge, West Cascades; OR. Cascades- Mud & lava flows; C. OR- High lava plains; E. OR & WA- Mixed species forests

Prunus emarginata (Bittercherry) & *P. virginiana* (Chokecherry)
Bittercherry-
Ubiquitous: W. OR- Columbia Gorge; S. OR- Siskiyou Mts. (west); E. OR & WA- Columbia Basin riparian comm.
Chokecherry-
W. OR- Interior Valleys, Columbia Gorge; E. OR- Columbia Basin riparian comm.

Rhamnus purshiana (Cascara)
W. OR- Interior Valleys, Columbia Gorge

Rosa nutkana (Nootka Rose)
Ubiquitous: N. OR Coast- Headlands; W. OR- Coast range, Interior Valleys; E. OR & WA- Columbia Basin, Mixed species forests

Salix scouleriana (Scouler's Willow)
W. OR- Coast Range, Interior Valleys, Columbia Gorge

Sambucus cerulea (Blue Elderberry)
Ubiquitous: W. OR- Coast Range (west), Interior Valleys, Columbia Gorge; E. OR & WA- Columbia Basin riparian comm.

Symphoricarpos albus & mollis (Snowberrys)
S. albus-
Ubiquitous: W. OR- Coast range, Interior Valley, Columbia Gorge; S. OR- Siskiyou Mts.; E. OR & WA: Columbia Basin
S. mollis-
same as above except not in E. OR & WA

FORBS/GRAMINOIDS/GRASSES

Achillea millefolium (Western Yarrow)
Ubiquitous varieties: W./C./E. OR mesic grasslands/woodland openings

Agropyron caninum (Wheatgrass)
Ubiquitous varieties: W./C./E. OR mesic grasslands

Agropyron spicatum (Slender Wheatgrass)
C./E. OR xeric grasslands

Aster chilensis
W. OR mesic grasslands

Balsamorhiza sagittata
C./E. OR mesic-xeric grasslands

Bromus carinatus (CA Brome-grass)
Ubiquitous varieties: W./C./E. OR mesic grasslands

Deschampsia caespitosa (Tufted hair-grass)
Ubiquitous: W./C./E. OR hydric-mesic grasslands

Elymus glaucus (Blue Wildrye)
Ubiquitous: W./C./E. mesic grasslands & woodland openings

Eriogonum umbellatum (Sulfur Flower Buckwheat)
Ubiquitous: W./C./E. OR xeric grasslands & woodland openings

Eriophyllum lanatum (Wooly Sunflower)
Ubiquitous: W./C./E. OR mesic-xeric grasslands

Eschscholzia californica (CA Poppy)
W. OR mesic grasslands

Festuca idahoensis (ID Fescue)
Ubiquitous: W./C./E. OR mesic-xeric grasslands

Festuca rubra v. rubra (Red Fescue Bunchgrass)
W. OR mesic grasslands

Juncus tenuis (Slender Rush)
8W. OR hydric-mesic grasslands

Juncus effusus (Soft Rush)
W. OR hydric-mesic grasslands & woodlands

Koeleria cristata (June grass)
Ubiquitous: W./C./E. OR mesic-xeric sand dunes, grasslands & woodland openings

Lupinus bicolor (Lupine)
W. OR mesic grasslands

Poa sandbergii (Bluegrass)
Ubiquitous: W./C./E. OR xeric sand dunes & grasslands

Pteridium aquilinum (Bracken Fern)
W./C. OR hydric-mesic grasslands & woodland openings

Sitanion hystrix (Bottlebrush Squirrel-tail)
Ubiquitous: W./C./E. OR xeric grasslands

Stipa comata (Needlegrass)
Ubiquitous: W./C./E. OR xeric sand dunes & grasslands

Solidago sp. (Goldenrod)
Ubiquitous varieties: W./C. OR mesic grasslands & woodland openings

GEOGRAPHIC CODES

Ubiquitous = occurring both west & east of the Cascade Range
Ubiquitous varieties = similar varieties found in west & east
W. OR = WESTERN OREGON
C. OR = CENTRAL OREGON
E. OR = EASTERN OREGON
comm. = plant community

FES COPY

July 23, 1992

Dr. Wesley Jarrell
Oregon Graduate Institute
19600 NW Von Neumann Dr.
Beaverton, OR 97006-1999

Dear Dr. Jarrell:

Thank you for the opportunity to read the draft report "St. John's Landfill Cover Vegetation Plan," prepared for the Solid Waste Department of the Portland Metropolitan Service District. The goals of the vegetation plan are to:

1) design a complex of natural plant communities along topographic and hydrologic gradients on and immediately adjacent to the capped landfill,

2) specify the proportions and management of soil constituents needed to develop a substrate with natural soil properties,

3) integrate the site with nearby natural areas and ensure that (no) negative impacts on such areas (do not) occur,

4) develop a monitoring program to document the effectiveness of the vegetation plan.

The report succeeds very well in responding to these goals. The design of the complex of natural plant communities clearly has been given much careful thought. The document is complete in listing the plants suitable for the different areas off the capped landfill. There is no doubt that the vegetation plan can succeed, provided that the second objective is successfully accomplished. Clearly the most difficult aspect of management of the St. John's Landfill is to provide an adequate substrate with natural soil properties. While many of the plant species which have been identified in this proposal will grow well in a shallow layer of soil, many of the plants which could add greatly to the habitat, require a much deeper soil than proposed. The concern here is with the stability of the soil and with the ability of the soil to provide adequate amounts of water to sustain the larger plants with water during the dry part of the year.

The proposal seems to be based on the premise that the entire landfill area will be covered with a membrane which is impermeable to water and to root penetration. This membrane will follow land contours. In certain areas slopes ranging from 10-20% occur. Important questions to consider are, therefore:

Can the layer of soil on this membrane be expected to remain stable during the projected lifetime of the project? My assumption is that the expected lifetime is indefinite, but certainly measured in decades.

Can the proposed soil thickness adequately sustain the desired vegetation?

The proposal contains as an addendum the paper "Geosynthetic Landfill Cover Design Methodology and Construction Experience in the Pacific Northwest," prepared by R. S. Thiel and M. G. Stewart of EMCON Company. This paper contains a careful analysis of construction criteria for membrane use in connection with landfill closure. Under the heading "top soil" the authors note that the thickness of the layer of topsoil depends on the type of vegetation to be established. The authors indicate that most designs specify a rooting layer of at least 30 cm, covered by 15 cm of organic soil. Then they say that the topsoil layers should be at least as thick as the rooting depth of the proposed vegetation. I am concerned about the adequacy of these criteria. The paper only deals with engineering criteria, construction issues and production. Certainly the engineering aspects of the placement of topsoil and the stability of the topsoil are very important, but the agronomic aspects of how the topsoil is to function with respect to plant growth are no less important. This report does not contain a single reference (citation) regarding successful vegetation establishment. In order to be more confident about the criteria of 30 cm of rooting soil and 15 cm of topsoil, I would consider further investigation of this matter extremely important. (My comments should not be interpreted as a review of this paper. This is a very good manuscript--agronomy is a different issue.)

In making the evaluation of the adequacy of soil thickness over the geomembrane, it must be recognized that the presence of the membrane makes any comparison between the engineered situation and the natural field situation impossible. The membrane breaks all capillary contact with the subsoil. Many plants which seemingly only extract water from a thin layer of soil do, in fact, depend on a water supply from the deeper soil layers. When the upper soil horizons dry out there is a continuous supply of water from lower soil horizons. This rate of supply may be extremely low, but often it is the difference between survival of the plants or not. A very low rate which is sustained over along period of time does move large amounts of substance, in this case, water.

The report states several requirements about the soil to be used in terms of its nutritional status and content on seeds of less desirable plants. Additionally criteria are established regarding the texture of the soil. These are all very important aspects, but in total, I consider these qualities to be less important than soil depth. The important aspect of soil depth is the ability of the soil to supply water, but that involves more than the water holding capacity layer by layer. It also involves capillary continuity.

Is the geomembrane necessary everywhere over the landfill?

My expectation is that the geomembrane has been specified to avoid possible leaching from the landfill caused by infiltration of water from rain. I suggest that it may not be necessary to place the geomembrane over the entire area. I would raise the following question: "What would the hydrology of this area be if the geomembrane were only placed in those areas where water accumulates and where standing water may be expected, that is, along the lower

parts of the slopes and in the drainage ways? In other words, what would the hydrology of the area be if the highest areas of the landfill were left without the geomembrane? In place of the geomembrane, one could use a soil with a low hydraulic conductivity so that the soil infiltration rate would be limited. Experience with modelling of water flow under unsaturated conditions suggest to me that the amount of infiltration would be very small and that the leaching from the landfill would be insignificant when compared with the subsurface hydrology of the natural environment. Remember that even when the entire landfill is covered with the geomembrane, there still is the contact of the lower boundary of the landfill. Consider this question: "What is the removal rate of dissolved material due to rise and fall of the water table?" My expectation is that leaching would contribute very little to this process. Given a little time I could probably prove this to you.

Stability of the soil layer above the membrane on steep slopes

As already mentioned, I am concerned about the stability of the fill on steep slopes. I tried to get some idea of the stability by reading the design papered by Thiel and Stewart. Unfortunately, I could not find an evaluation of the thickness of the soil layer in terms of its stability. This paper is quite hypothetical. There is no reference to actual validation of the models which are being used. In nature, things proceed very differently from how they proceed in textbooks, and this seems to be a textbook approach. Furthermore, the analysis does not allow for soil erosion, which always proceeds in unpredicted ways. The essence of soil erosion is that water rapidly accumulates in the very lowest spot of the profile, and then proceeds to cut channels which very quickly lead to removal of soil. The soil layer on the steep slopes must be sufficiently thick to provide a foothold for the plant community but also it must resist erosion and hold the soil in place.

From an environmental quality perspective there are some important trade-offs to consider here. Can saving be achieved by not covering the entire landfill with a membrane but by making a larger investment in soil thickness and soil stability? What would it look like if one could guarantee zero contribution to leaching due to infiltration of rain water but see all the topsoil wash away due to erosion?

Additional Comment

I am returning my copy of the report to you. I have written notes in several places, and can discuss those either by phone or at some future meeting.

Thank you for the opportunity to read this report.

Sincerely yours,

Larry Boersma

Larry Boersma
Professor of Soil Science

pw

Land Imprinting for Vegetative Restoration

By Robert M. Dixon

A new tilling and planting process that imitates the action of animal hooves on soil and was developed for use in restoring perennial grasses and shrubs in overgrazed rangelands in arid and semiarid regions of the world is now being used as a technique for ecological restoration.

The technique, called "Imprinting," has already proved its value in the restoration of perennial grasses and shrubs on severely degraded rangelands in western United States, and we believe it has considerable potential in other areas, especially on steeply sloping forests and prairies in humid and subhumid regions.

Imprinting is the result of extensive basic and applied research carried on originally by the USDA's Agricultural Research Service in Tuscon, and now continuing in the context of The Imprinting Foundation, a non-profit organization incorporated in 1986. While novel in some respects, this work is part of a current trend in U.S. agricultural practices toward less tillage, more surface mulching, more polycultures, and less reliance on agricultural chemicals for soil fertility and pest control.

Imprintation entails the use of an angular tooth or foot to create funnel-shaped indentations in the soil surface. It differs dramatically from conventional methods of tillage such as plowing, disking, cultivating or drill-seeding in that it does not turn over the soil and entails minimal disruption of the surface litter.

The resulting depressions serve to accumulate both seed and surface litter and to encourage infiltration of water, creating favorable micro-sites for germination and seedling establishment.

In its present form, this method is based on 15 years of research carried out under a wide variety of conditions in Wisconsin, Montana, Nevada and Arizona. It has a natural counterpart in the hoof-action of ungulates, and its development, in turn, has provided a number of insights into the ecological significance of this natural form of soil disturbance (Anderson, 1987; Dixon, 1988).

As a result of this research we have concluded that hoofprints resulting from once-over intensive grazing (followed by rest from grazing for several years) provide sites for seedling establishment, and so play a key role in the development and maintenance of vegetation under special conditions such as those created by free-roaming, wild herds of ungulates (Savory, 1978). Desertification may occur when grazing is either too severe, reducing vegetation below a critical threshold for recovery, or when it is insufficient to create microhabitats needed for the establishment of seedlings.

Imprinting counteracts the smoothing and sealing effects of desertification by creating artificial roughness at the soil surface in the form of relatively stable, angular depressions that funnel seed, litter and rainwater together to provide favorable conditions for germination and growth. We have found this is especially effective on

Like a butter mold, imprinter leaves pattern on land being prepared for revegetation.

relatively dry, or excessively drained sites where water supply may be a problem limiting seedling establishment.

Most of our experience with this method has been in the Sonoran and Chihuahuan Desert grasslands and shrublands of the southwestern United States. Others have used it in the sagebrush-bunchgrass areas of the Great Basin. The results usually have been greatly superior to conventional methods, especially where low precipitation is the main factor limiting seedling establishment.

This being the case, it seems likely that imprinting would also prove effective as a tool for the revegetation of dry prairies, dunes, forests on steep slopes, cliffside communities and other communities where water supply or dessication is likely to be a problem during seedling establishment.

Over the years we have developed a number of techniques for imprinting under various soil, vegetative and climactic conditions. The most common method involves the use of a heavy steel roller with angle-irons welded

onto the surface to create angular teeth, which penetrate the soil surface. This device, somewhat like a large rolling pin with a waffled surface, leaves a pattern of angular depressions on the soil surface, usually without any beforehand tillage. Seeds are scattered just ahead of the roller and are pressed into the imprinted surface. In this way we are able to imprint and seed 10 to 50 hectares per day (depending on the length of the roller) at a cost of some $50 per hectare. We have also devised specialized equipment, including hand-operated equipment for small-scale projects, and various imprinting depths and patterns adapted to specific conditions. In general, the drier a site, the deeper and wider-spaced the imprints should be.

Following imprinting, each successive rain washes more seed and litter into the imprinted furrows, thereby creating micro-sites favorable for seedling establishment. At the same time, the depressions increase percolation of water into soil, reduce runoff, and funnel water to sites where seed and mulch are most likely to accumulate. In most soils, these artificial depressions are surprisingly durable. Even without any existing vegetative cover, imprints are usually stable enough to function until adequate rain falls even if, as is often the case in our area, this may take several years.

Using this technique we have been able to establish adapted perennial grasses and shrubs on sites receiving as little as 200 mm annual rainfall without any irrigation or mulching material other than that already existing on the site.

While this technique was developed mainly for agricultural purposes it has obvious implications for restoration ecology as well, since it suggests that hoofprints and other kinds of wild animal disturbance may play a crucial role in the ecology of various communities. This in turn has important implications for the management of these communities, a number of which I have discussed in some detail elsewhere (Dixon, 1988). Of special importance is the fact that it lends support to the suggestion that the maintenance of certain kinds of communities such as the tall-grass prairies, which coevolved with large ungulates, may benefit from natural grazing.

Robert M. Dixon was formerly a soil scientist with the Agricultural Research Service, USDA. He is currently chairman of the Imprinting Foundation, 1231 E. Big Rock Rd., Tucson AZ 85718 (602) 297-6165.

References

Anderson, R. 1987. Grassland Revegetation by Land Imprinting: A New Option in Desertification Control. Desertification Control Bulletin, No. 14. United Nations Environment Programme. pp. 38–44.

Dixon, R.M. 1988. Imprintation: A Process for Land Restoration: Restoring the Earth Conference 88. University of California, Berkeley, January 13–16. In press.

Savory, A. 1978. A Holistic Approach to Ranch Management Using Short Duration Grazing. In Proc. International Rangeland Congress. Soc. Range Manage., Denver, Colo. pp. 555–557.

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