Prepared for:
Seaboard Group II and the City of Highpoint

Proposed Full-Scale Phytoremediation System Planting Plan – Final Report

City of Highpoint Landfill, Jamestown, NC

ENSR Corporation
November 8, 2006
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City of Highpoint Landfill, Jamestown, NC

Ari Ferro, Ph.D.

Prepared By

Carl E. Tammi, PWS

Reviewed By

ENSR Corporation
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1.0 Introduction

This report describes the proposed full-scale Phytoremediation System Planting Plan for the Seaboard Group II/City of High Point Landfill Site prepared by ENSR. This plan represents the culmination of over 5 years of concept evaluation, design, greenhouse testing and field-scale piloting. This report specifically describes the proposed site preparation activities and installation/planting of bare-root seedlings on the landfill cap. While the ultimate plan is to irrigate these trees with recovered groundwater containing 1,4 - dioxane, a separate plan will be submitted describing the proposed irrigation system, installation methods and instrumentation.

The current plan will allow us to take advantage of the 2007 growing season to establish the phytoremediation system. Following this plan, the trees must be installed as dormant plantings in January-February 2007. In order to install the trees within this timeframe certain site preparation activities must be conducted this autumn, by Mid-October, 2006.

This report is organized into sections describing the background and rationale, the size and location of the proposed full-scale system (including the deciduous stands and coniferous stands), the proposed site preparation activities and description of the proposed tree species, plant stock, planting methods and layout. Also included in this report is a schedule for the installation, inspection, and repair of sediment fences that will prevent erosion of the landfill cap.

2.0 Background

A plume of contaminated groundwater originates from the Former Seaboard Facility as well as from leachate from the adjacent City of High Point Riverdale Drive Landfill. The plume contains chlorinated volatile organic compounds (cVOCs) and 1, 4 – dioxane, and is migrating toward the Deep River. A remediation strategy has been developed by the Seaboard Group II and the City of High Point, that involves the use of a series of groundwater recovery wells to hydraulically contain the plume and protect the Deep River. The wells would pump at a combined rate of approximately 50 gallons per minute (gpm) year round. Part of the long-term strategy for the treatment of the recovered groundwater includes the following natural systems: 1) a constructed treatment wetland to remove cVOCs via reductive dechlorination; and 2) an upland phytoremediation system to remove 1, 4 – dioxane.

Effluent from the treatment wetland would be used to irrigate large stands of trees located on the western and eastern lobes of the landfill (the upland phytoremediation system). The trees would use the water via transpiration and remove the 1, 4 – dioxane via phytovolatilization. ENSR and Phytokinetics, Inc. have demonstrated in several greenhouse pilot studies that 1,4 - dioxane can be readily taken up by various tree species and phytovolatilized (i.e. exit the plants via the leaves), and it is anticipated that the concentration of dioxane in the irrigant will be < 10 mg/L. The phytoremediation system must operate year-round, and will encompass approximately 37.9 acres.

The performance requirements for the upland phytoremediation system, as specified by the North Carolina Department of Environment and Natural Resources, are that there will be no increase in the rate of landfill leachate production (gallons per month) and that there will be no leaching of dioxane below the root-zone of the trees. Therefore, it is important that the trees use all of the irrigation water plus all of the input from precipitation, and that the water holding capacity of the landfill matrix never be exceeded.

The extracted groundwater effluent that would be used as irrigant is moderately saline, mainly due to bicarbonate salts. It also contains sufficient manganese (Mn) to be toxic to certain sensitive tree species. If the tree stand were continuously irrigated with this water, the soil in the root zone would become saline and could cause toxicity. Therefore, the management strategy for maintaining plant viability is to irrigate two different tree stands: An 8.9 - acre deciduous stand will be irrigated from June through the end of September, and all or part of a 29-acre coniferous stand from October through the end of May. The irrigation of the stands would be seasonally alternated to prevent salt accumulation in the root-zone of the trees. Winter rains would leach salts from the root-zone of the dormant deciduous stand, and irrigation with city water would leach salts from various portions of the conifer stand during the fall and spring months. Data already gathered by ENSR, as reported in the *Landfill Suitability Assessment* conducted in 2006, suggested that the landfill is sufficiently well-drained for this approach to be feasible.

Preliminary studies have been carried out to identify a variety of deciduous and coniferous tree species that would be suitable for the phytoremediation system. In greenhouse studies, saplings established in pots were irrigated with Seaboard groundwater spiked with 1, 4 – dioxane, and plant uptake of dioxane was measured (the dioxane concentration was determined in the xylem sap). Previous research indicated that once dioxane is taken up it is phytovolatilized (i.e., it is not sequestered in the plant tissue nor metabolized), and therefore these plant uptake measurements were a good index of the ability of a tree species to phytovolatilize dioxane. Other greenhouse studies were carried out to identify tree species that were tolerant of the moderately saline, Mn containing, groundwater. In addition to the greenhouse studies, pilot-scale studies on the landfill are in-progress, and will continue to provide important information concerning the suitability of various tree species as well as cultural/irrigation practices.

3.0 Proposed Technical Approach for Full-Scale Tree Planting

The section describes the approach for the planting of the trees that will comprise the full-scale 35 acre phytoremediation system on the closed City of High Point Landfill located at 5873 River Dale Road, Jamestown, North Carolina, 27260. The trees will be planted in January - February, 2007, on most of the western lobe of the landfill, and a portion of the eastern lobe (Figure 1). The trees, both deciduous and coniferous species, will be planted as bare-root saplings directly into the soil of the existing landfill cap using conventional planting methods. There will be four different species of deciduous trees and five species of conifers. The trees will be planted in long straight rows, 10 ft spacing between the rows, and 10 ft spacing of the trees within a row (435 trees/acre; 16,485 trees total for 37.9 acres).

During the autumn of 2006, some of the vegetation currently established on the landfill must be removed. The vegetation is comprised of grass, herbaceous vegetation that is tall and aggressive (*Lespedeza sericea*) and a few trees. These plants would compete with the saplings, especially during the first few growing seasons, and small trees cannot be successfully established in the presence of these weeds. The grasses and weeds would compete for sunlight and water and would effectively screen out the young trees.

An irrigation system will be installed to deliver recovered groundwater to the tree stands. Preliminary plans specify 17 irrigation zones, with approximately 2.23 acres per zone. Each zone will contain a single tree species (Figure 3). The irrigation water will be delivered via drip-lines installed on the ground surface and running straight, down the rows of trees. One reason that some of the trees currently established on the landfill must be removed is to clear straight pathways for the drip lines. There will be five 0.62 gallon per hour (gph) pressure-compensated drip emitters per tree

While the proposed site preparation and planting project is scheduled to start immediately and to extend through early 2007, the proposed irrigation system will not be installed until 2008. The rationale for this schedule is based on a number of factors, including the need to collect data from the pilot plots after they have been irrigated for several months with recovered ground water. Irrigation of the conifers in the two pilot plots is planned for fall 2006 through spring 2007, and irrigation of the deciduous trees in the pilot plots will begin in May, 2007. We want evaluate different management strategies for the accumulation of bicarbonate salts in the soils of the pilot plots prior to the final design and implementation of the full-scale irrigation system. Moreover, during the first growing season for the full-scale tree stands, precipitation will be sufficient to support the young tree seedlings. As a contingency plan in the event of an extended dry period, ENSR will water the trees between June-September with sprinklers or with a water truck.

Monitoring instrumentation also will be installed for the various irrigation zones in the full-scale plantation at the time that the irrigation system is installed. Monitoring of the phytoremediation system will be carried out using soil moisture/electrical conductivity sensors installed at 1, 2, and 3 – ft below ground surface, and drain gauges to measure the rate of water percolation below the root – zone of the trees (Figure 5). The instrumentation will be attached to a system of dataloggers that can store and transmit the data.

3.1 Location of the propose 37.9 acre phytoremediation system on the City of High Point Landfill

The location of the tree stands on the landfill is shown in Figure 3. Note that the trees will be planted on most of the western lobe of the landfill in an area of about 29.9 acres. Trees will also be installed on 8 acres of the eastern section of the landfill. No trees will be planted on areas of the landfill in which the slope is greater than 15 %, and in these areas the existing vegetation will be left undisturbed.

3.2 Site preparation activities

Removal of the vegetation currently growing on the landfill will be carried out in areas that will be used for the phytoremediation system. These activities will be carried out in a phased approach including herbicide spraying, mowing of both the grass and the brush, and by the cutting and removal of certain trees. On October 25, 2006, ENSR uniformly sprayed the entire planting area that has a slope of less than 10 %, and selectively sprayed 6 ft diameter circles for the planting locations in areas where the slope is between 10 % and 15 % (Figure 2). The vegetation between the planting circles was not be sprayed. The purpose of this selective spraying on the steeper areas is to reduce the possibility of soil erosion. No spraying, mowing, or planting will be carried out on areas of the site with slope > 15 %.

In the areas with < 10 % slope, the vegetation was sprayed, and in early November the vegetation will be mowed. In areas with a slope between 10 % and 15 %, the vegetation first was cut, the planting locations for the trees marked, and the 6 ft diameter circles sprayed with herbicide.

Large brush will be cut and cleared and some of the trees already growing on the landfill will be cut in order to establish straight-line pathways for the irrigation lines. The following are detailed specifications on the proposed site preparation activities:

3.2.1 Spraying with herbicide

The herbicide consisted of 8 qts Razor Pro (Glyphosphate) plus 1 qt. Red River 90 (surfactant) per acre. The chemicals were delivered with sufficient water at a rate of 20 – 30 gallons per acre. Application records were kept during the application (carried out by Woodland Forestry, a NC licensed applicator). In the areas with < 10 % slope, the application was made with a 4-wheel drive tractor with a custom built boomless sprayer. In areas with a slope > 10 % and < 15 %, the herbicide was applied by hand sprayer unit mounted on an ATV. Inspection of equipment prior to beginning work was carried out by an ENSR representative and ENSR provided oversight of the spraying application. No herbicide will be sprayed on areas of the site with slope greater than 15 percent.

3.2.2 Mowing of weeds and brush, and selective tree removal

The grass and brush will be cut using a large mower pulled behind a tractor and powered with the PTO of the tractor. In order to clear straight line pathways for the drip lines, a few trees currently established on the landfill will be removed. The trees will be cut down using a chain saw and pulled off the planting area. No vegetation will be mowed or cut in areas of the site with slope > 15 %.

3.2.3 Installation, inspection, and repair of sediment fences

Sediment fences will be installed in the areas of the landfill in which trees are planted having a slope of between 10 % and 15 %. The fences will be installed according to the guidance provided in the Erosion and Sediment Control Planning and Design Manual, Section 6.62, June 1, 2006. The manual was prepared by the North Carolina Sedimentation Control Commission, the North Carolina Department of Environment and Natural Resources, and the North Carolina Agricultural Extension Service. The fence will be installed after all of the mowing has been completed, and the brush and certain trees removed.

The sediment fences will be inspected twice monthly for the first six months after installation and monthly thereafter. Moreover, the fences will be inspected within two days following storms in which precipitation is greater than 0.24 inch. Note that a rain bucket has been installed at the landfill site, and that the data for precipitation is continuously stored on a data logger that can be remotely accessed by the ENSR Raleigh office. Any damage to the sediment fences will be repaired within one week after discovery.

3.3 Planting approach

3.3.1 Species

The tree species planned for the large scale installation were selected based on the results of the greenhouse studies mentioned above. After receipt of the planting stock, the material will be stored in a refrigerated truck, on the landfill site, until the day of the planting.

Coniferous species: loblolly pine (*Pinus taeda*); western red cedar (*Thuja plicata*), pond pine (*Pinus serotina*), eastern red cedar (*Juniperous virginiana*), and Japanese black pine (*Pinus thumbergi*). The planting stock will be 1 to 2 ft tall, one-year old, bare-root seedlings.

Deciduous species: Kentucky coffee tree (*Gymnocladus dioicus*); Chinese elm (*Ulmus parvifolia*); Russian mulberry (*Morus alba*), and common hackberry (*Celtis occidentalis*). The planting stock will be 1 to 2 ft tall, one-year old, bare-root seedlings.

3.3.2 Methods

The bare-root saplings will be planted with a planting machine in areas with a slope < 10 %. This device is pulled behind a tractor, and has a sharp steel disk that opens a slit in the soil approximately 1 ft deep (Figure 5). A wedge widens the slit, and the operator lays the seedling into the slit. Finally wheels are used to close the planting slit.

Saplings will be planted by hand in areas of the site with slope > 10 %. Planting by hand results in very little soil disturbance. No trees will be planted in areas of the site with slope > 15 %.

3.3.3 Layout

The trees will be planted in approximately 2.23 acre blocks that correspond to the irrigation zones (Figures 3 and 4). Thus, the irrigation system can be independently regulated for a given species. This approach is important because the rate of water use, and the tolerance of certain conditions of soil moisture, is species specific.

3.4 Fencing

A perimeter fence (detail indicated on Figure 5) will be installed around the entire limits of the 8.9 acre deciduous phytoremediation system. This will be a 6 – 8 ft tall field (wire weld) fence installed with metal posts set 2-3 ft below ground. The fence is primarily designed to eliminate or minimize browsing by deer on the young seedlings. While the conifers likely would not be browsed, we may need to consider fencing some areas containing specific conifer species.

3.5 Draft Irrigation System

The drip-lines will be ½ inch diameter Netafim tubing that has pressure compensated 0.62 gph drip emitters spaced at 1 ft intervals as integral components of the tubing. The drip-lines will be installed above-ground about 6 in from the base of the trees.

The system must deliver 50 gpm year round to the various zones within the 37.9 stand (435 trees/acre). There will be five 0.62 gph drippers per tree (22.47gpm/acre). The irrigation system therefore will be divided up into 17 zones, each receiving 50 gpm of irrigation water (2.23 acres/zone). There will be four deciduous zones (8.9 acres) irrigated one at a time from June to September, and 13 coniferous zones (29 acres).

In any give year, all 13 coniferous zones will be irrigated with groundwater one at a time in November, Dec., Jan., and Feb. when evapotranspiration rates are lowest. Only 9 of the coniferous zones will be irrigated one at a time in Oct., March, April and May. The remaining 4 conifer zones will not be irrigated with groundwater

in Oct., March April, and May, but will be irrigated one at a time with city water in order to leach the salts. From year to year, the conifer zones that are leached will be rotated.

3.6 Maintenance and Inspection

The tree stands will be kept weed-free by spraying pre-emergent herbicide (e.g. Oust) in March of each year to prevent the weed seed from germinating. In the areas of the site with slope > 10 % and < 15 %, the grass and weeds between the trees will be mowed regularly. In the areas of the site with slope <10%, where all of the grass and weeds will have been sprayed, 6-ft wide strips of grass will be planted between the tree rows. Silt fences will be inspected and repaired as outlined in Section 3.2.3.

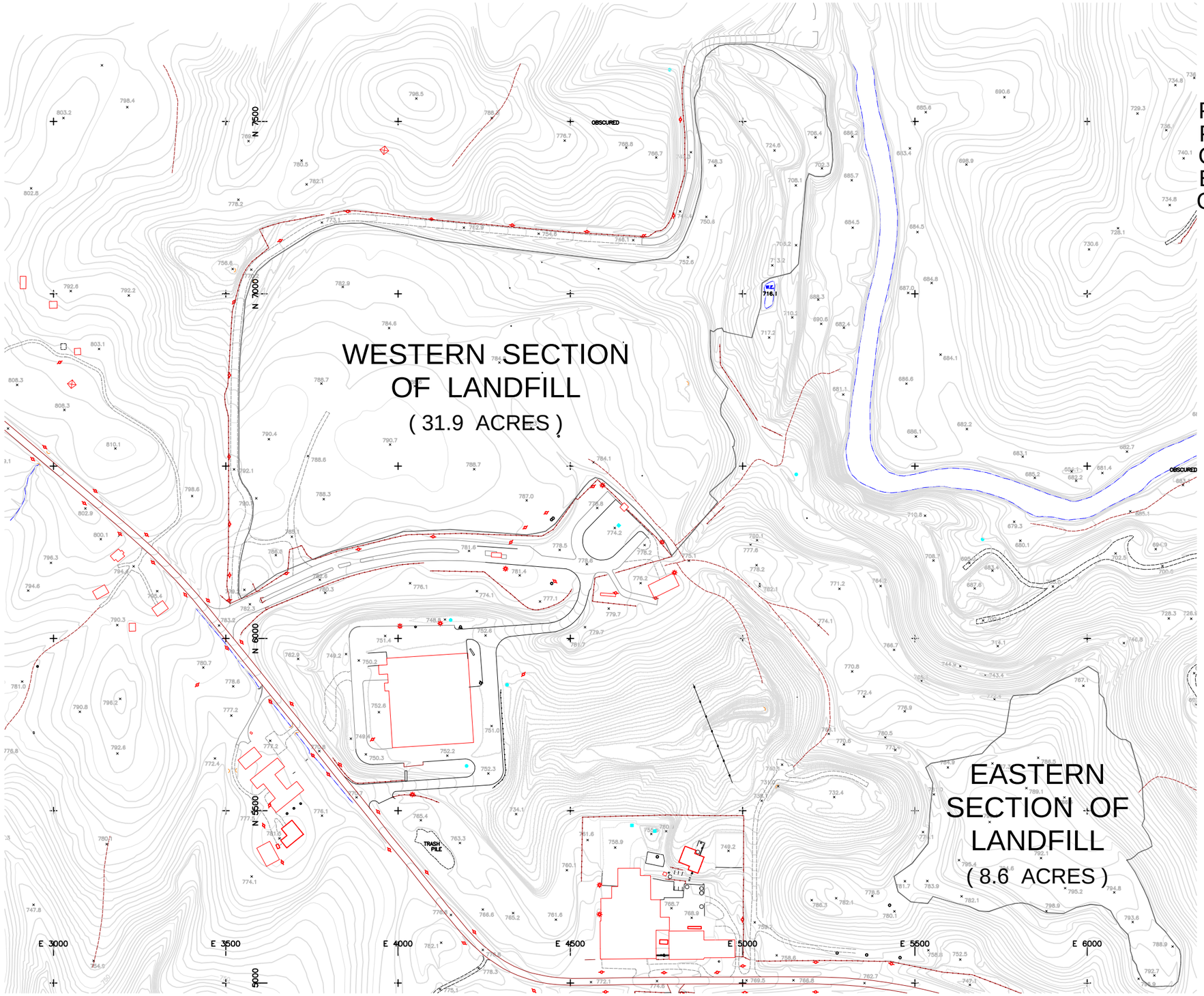
After the installation of the tree stand, the landfill cap will be inspected for signs of soil erosion on a monthly basis, and The Seaboard Group II will take financial responsibility for the repair of the cap.

3.7 Proposed Schedule and Sequence

The following ***weekly*** schedule and sequence is proposed for the tree planting associated with the full-scale phytoremediation system:

- Mark out site (perimeter; 10 % topographic line; 15 % topographic line), and mow areas that have a slope between 10 to 15 percent; 10/9/06
- Flag tree planting locations in areas with slope between 10 – 15 %; 10/23
- Spray area with < 10 % slope with herbicide. Spray 6 ft diameter circles around the flagged tree planting locations in areas with 10 – 15 % slope; 10/23/06
- Mow areas with < 10 % slope, install silt fences in areas > 10 % and <15 % slope; 11/06
- Order trees by 10/30/06
- Plant trees, install deer fencing; 1/15/07 to 2/28/07
- Maintain tree stand and the sediment fences, and inspect for erosion of the landfill soil cap after 3/1/07
- Finalize irrigation system technical approach and design; 9/07

Figures



NOTE:

PERIMETERS OF PLANTING AREAS ON WESTERN AND EASTERN SECTIONS OF LANDFILL

REVISIONS		
NO.:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:

DRAWN BY: SPR

CHECKED BY:

APPROVED BY:

ENSR | AECOM

ENSR CONSULTING AND ENGINEERING (NC), INC.
RALEIGH, NORTH CAROLINA 27616
PHONE: (919) 872-6600
FAX: (919) 872-7996
WEB: HTTP://WWW.ENSR.AECOM.COM

EXTENT OF PLANTING PLAN
HIGH POINT LANDFILL

SEABOARD GROUP II
HIGH POINT, NORTH CAROLINA

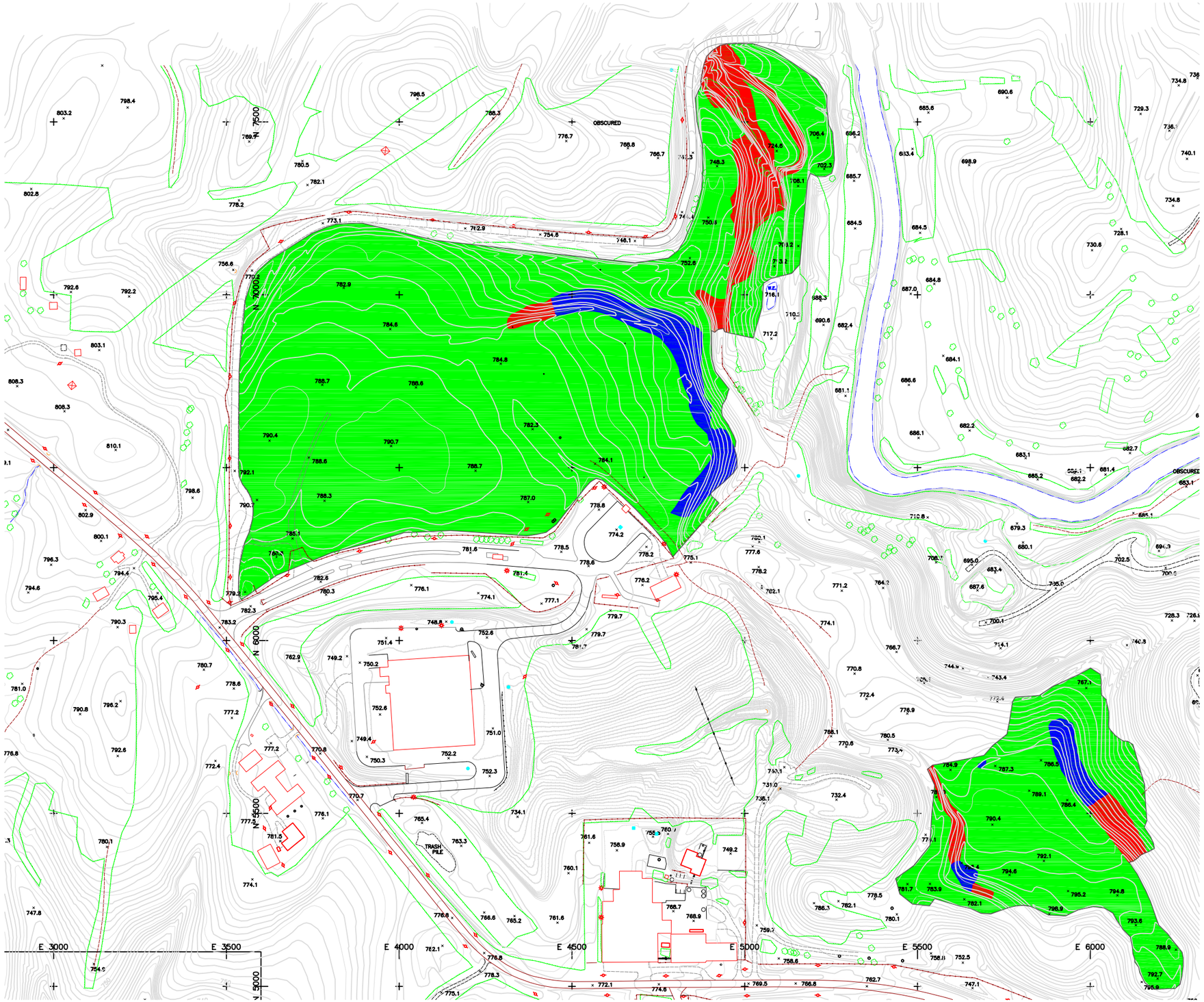
SCALE:	DATE:	PROJECT NUMBER:
1 cm = 124 ft	9/25/06	08734-679

FIGURE NUMBER:

1

SHEET NUMBER:

B60641B



WESTERN LANDFILL

LESS THAN 10% SLOPE
(APPROXIMATELY, 28.5 ACRES)

10–15% SLOPE
(APPROXIMATELY, 1.4 ACRES)

GREATER THAN 15% SLOPE
(APPROXIMATELY, 2 ACRES

NOTE:

TOTAL LIMITS OF PLANTING AREA EQUALS A TOTAL OF 37.9 ACRES BETWEEN THE EASTERN AND WESTERN LANDFILL AREAS

EASTERN LANDFILL

LESS THAN 10% SLOPE
(APPROXIMATELY, 7.6 ACRES)

10–15% SLOPE
(APPROXIMATELY, 0.4 ACRES)

GREATER THAN 15% SLOPE
(APPROXIMATELY, 0.6 ACRES

REVISIONS			
NO.:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:
DRAWN BY: SPR
CHECKED BY:
APPROVED BY:

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ENSR CONSULTING AND ENGINEERING (NC), INC.
RALEIGH, NORTH CAROLINA 27616
PHONE: (919) 872-6600
FAX: (919) 872-7996
WEB: HTTP://WWW.ENSR.AECOM.COM

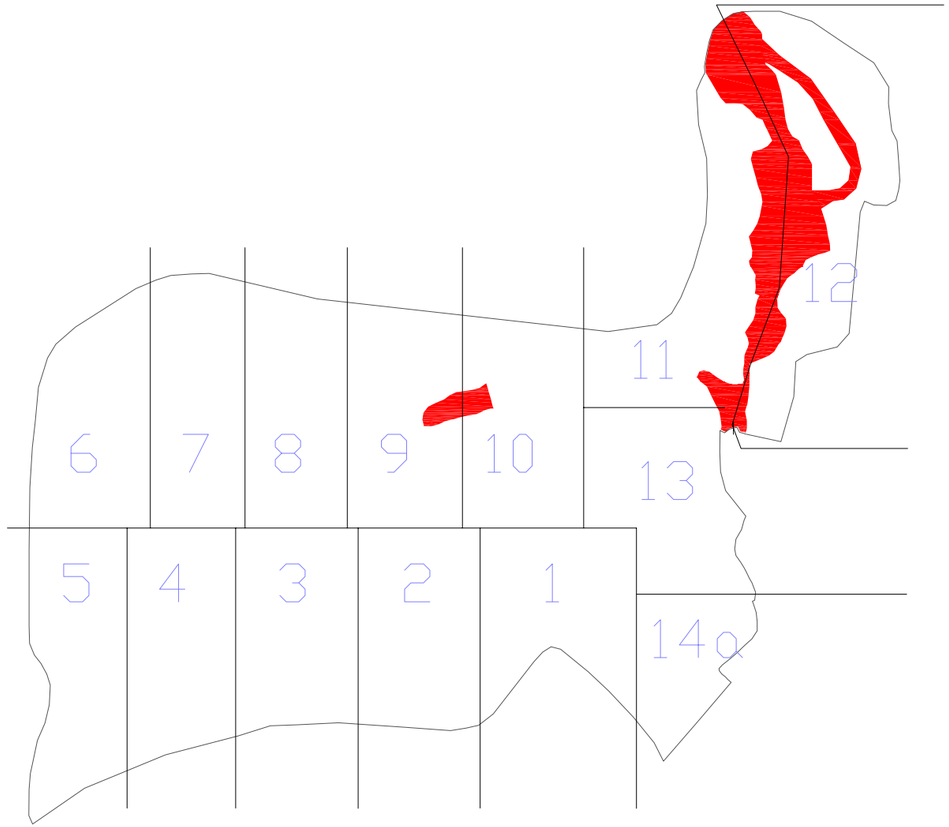
SLOPE DEFINITION PLAN HIGH POINT LANDFILL

SEABOARD GROUP II
HIGH POINT, NORTH CAROLINA

PROJECT NUMBER: 08734-679
DATE: 10/13/06
SCALE: 1 cm = 124 ft

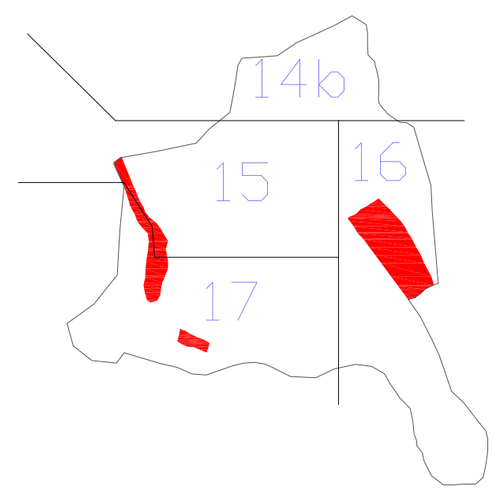
FIGURE NUMBER: 2

SHEET NUMBER: B60657B



ZONE #	TREE SPECIES
1	WESTERN RED CEDAR
2	JAPANESE BLACK PINE
3	POND PINE
4	HACKBERRY
5	KY COFFEETREE
6	RUSSIAN MULBERRY
7	CHINESE ELM
8	WESTERN RED CEDAR
9	EASTER RED CEDAR
10	LOBLOLLY PINE
11	WESTERN RED CEDAR
12	EASTERN RED CEDAR
13	POND PINE
14a & 14b	LOBLOLLY PINE
15	POND PINE
16	JAPANESE BLACK PINE
17	LOBLOLLY PINE

RED AREAS
INDICATE SLOPES
GREATER THAN
15% (NO PLANTING/
IRRIGATION IN THESE AREAS)



REVISIONS			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY: BB HOBBS
DRAWN BY: SPR
CHECKED BY:
APPROVED BY:

ENSR | AECOM

ENSR CORPORATION
RALEIGH, NORTH CAROLINA 27616
PHONE: (919) 872-6600
FAX: (919) 872-7996
WEB: HTTP://WWW.ENSR.AECOM.COM

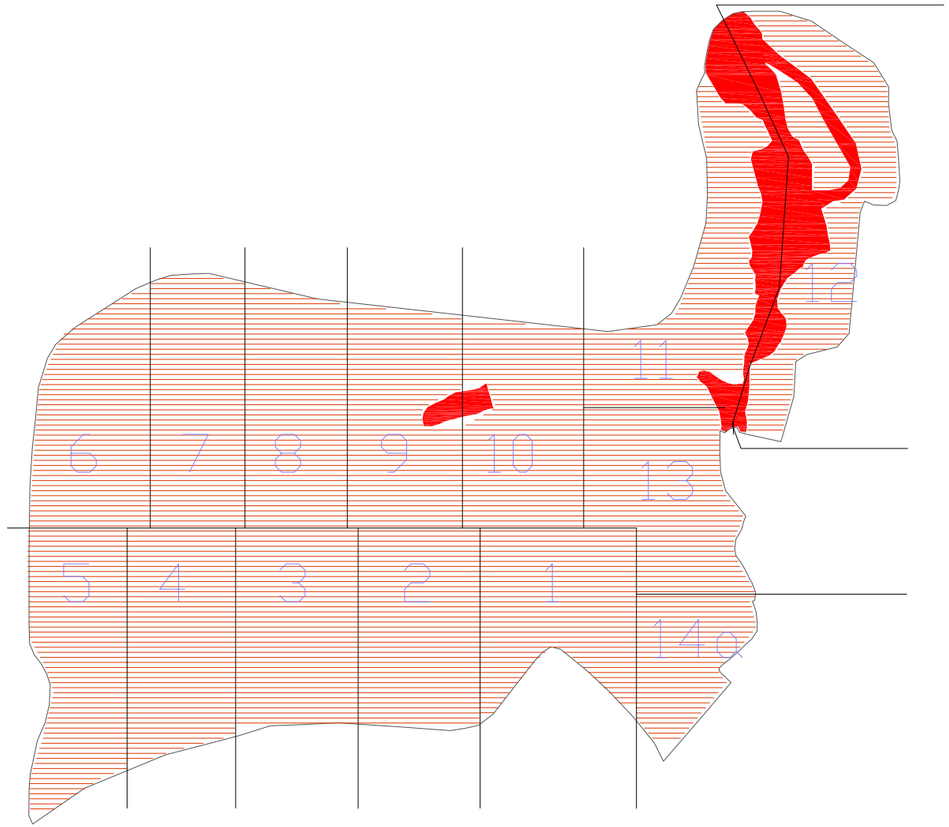
PLANTING LAYOUT

SEAVBOARD GROUP II
HIGH POINT, NC

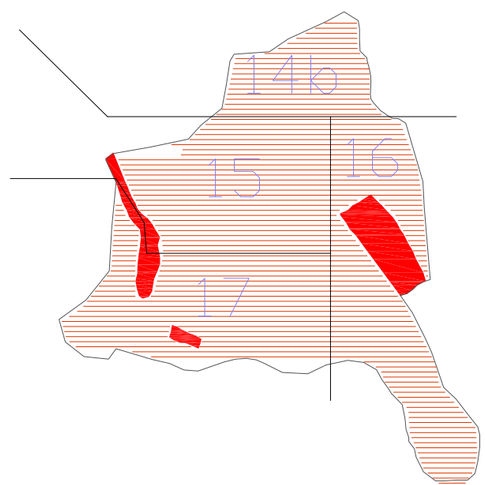
PROJECT NUMBER: 08734-679
DATE: 11-3-06
SCALE: 1"=300'

FIGURE NUMBER: 3

SHEET NUMBER: B60640B



RED AREAS
INDICATE SLOPES
GREATER THAN
15% (NO PLANTING/
IRRIGATION IN THESE AREAS)



REVISIONS			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY: BB HOBBS
DRAWN BY: SPR
CHECKED BY:
APPROVED BY:

ENSR | AECOM

ENSR CORPORATION
RALEIGH, NORTH CAROLINA 27616
PHONE: (919) 872-6600
FAX: (919) 872-7996
WEB: HTTP://WWW.ENSR.AECOM.COM

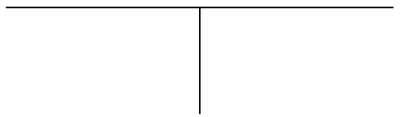
IRRIGATION LAYOUT

SEAVBOARD GROUP II
HIGH POINT, NC

PROJECT NUMBER: 08734-679
DATE: 11-3-06
SCALE: 1"=300'

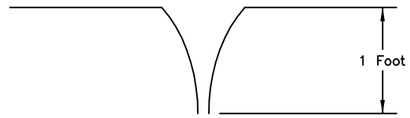
FIGURE NUMBER: 4

SHEET NUMBER: B60642B



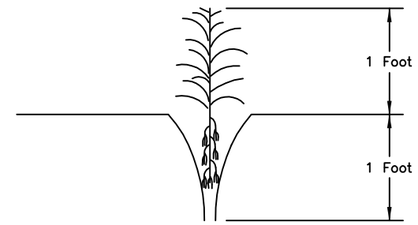
SLIT IN SOIL FORMED BY DISK

NOT TO SCALE



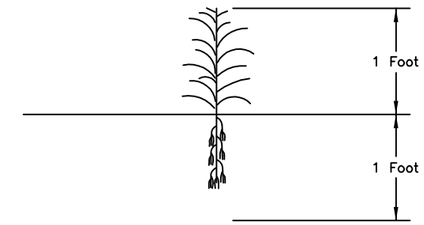
SLIT WIDENED USING WEDGE

NOT TO SCALE



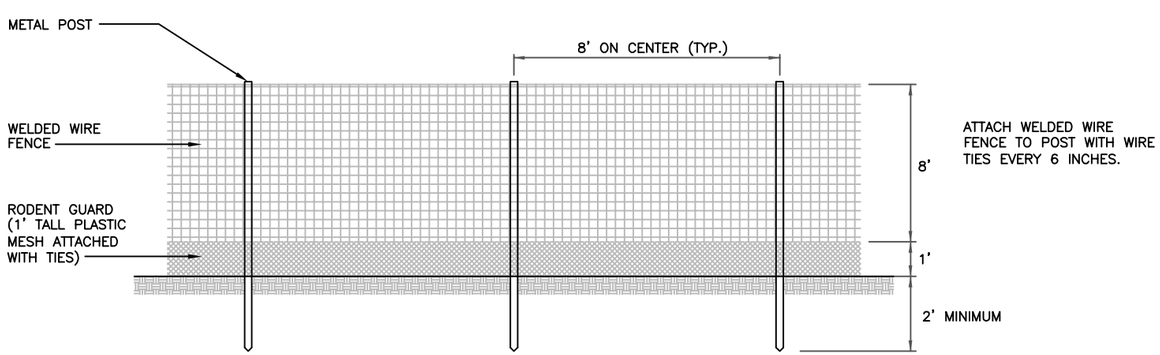
SEEDLING PLACED IN PLANTING FURROW

NOT TO SCALE



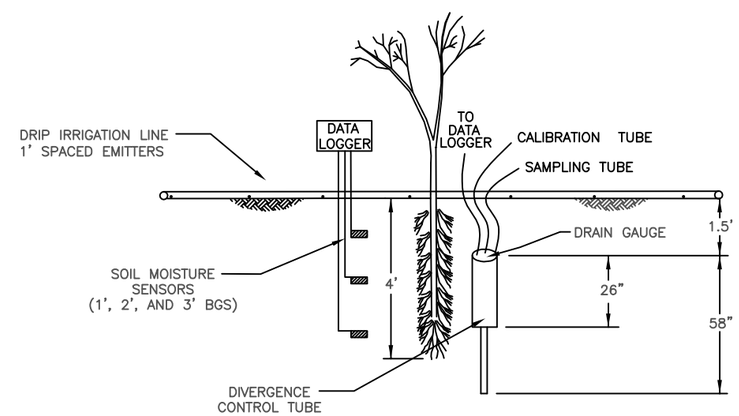
FURROW CLOSED USING WHEELS

NOT TO SCALE



DECIDUOUS AREA FENCE WITH RODENT GUARD

NOT TO SCALE



DRAIN GAUGE AND SOIL MOISTURE DETAIL

NOT TO SCALE

REVISIONS		
NO.:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:

DRAWN BY: SPR

CHECKED BY:

APPROVED BY:

ENSR | AECOM

ENSR CONSULTING AND ENGINEERING (NC), INC.
RALEIGH, NORTH CAROLINA 27616
PHONE: (919) 872-6600
FAX: (919) 872-7996
WEB: HTTP://WWW.ENSR.AECOM.COM

CONSTRUCTION DETAILS

SEABOARD GROUP II
HIGH POINT, NORTH CAROLINA

PROJECT NUMBER: 08734-679

DATE: 9/25/06

SCALE: AS NOTED

FIGURE NUMBER: 5

SHEET NUMBER: G60643B