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Focused Feasibility Study
Final Cover System

Woodlawn Landfill
Cecil County, Maryland

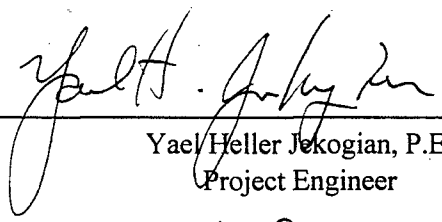
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Our Ref.:
NP000344.0002.00025

Date:
August 1998

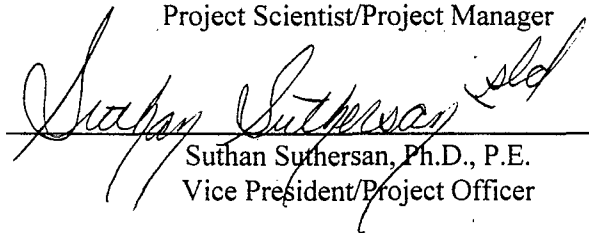
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Executive Summary

This Focused Feasibility Study utilizes USEPA criteria for remedy evaluation in a thorough analytical comparison of the single-barrier cap prescribed by the Record of Decision (ROD) and an alternative vegetative cover for the Woodlawn Landfill Site. It is recommended that the vegetative cover be implemented on a pilot-test basis as a conclusion of this analysis. The vegetative cover alternative is expected to satisfy the remedial action objectives, and to exceed the single-barrier cap in remedial performance.

Conducting a five-year pilot test is warranted for several reasons. The pilot test can be done without endangering human health or the environment. Extensive data have been collected at the Site demonstrating that groundwater constituents are not migrating to endanger local residents' water supply. The extensive monitoring well network assures that any significant expansion of the zone of affected groundwater would be detected well before it could threaten public health. The knowledge gained during the pilot test will be useful to regulatory agencies in future decision-making at other landfills across the country. The vegetative cover also offers additional benefits, including ecological, economic and public safety benefits, which confirm it as the right technology for this Site.

The fate of the most important Site groundwater constituents of concern (COCs) is governed by natural attenuation mechanisms. Data collected over more than 15 years demonstrate that natural attenuation is effective in both containing further migration of COCs from the Site and in reducing their concentrations. A vegetative cover will promote these ongoing processes by allowing the influx of oxygen into the subsurface, to assist in the breakdown of landfilled waste and groundwater COCs. In contrast, the single-barrier cap, by blocking the migration of oxygen to the subsurface, could actually retard these processes and delay achievement of the groundwater cleanup objectives. Natural hydraulic controls and the continued effect of natural attenuation mechanisms will reduce the toxicity, mobility, and volume of the COCs in groundwater. Extensive monitoring of groundwater and surface water, as necessary, will provide a reliable means of confirming the ongoing effectiveness of the vegetative cover.

Compared to the ROD-prescribed remedy for the Site, a vegetative cover:

- will pose fewer short term risks to human health and the environment;
- will be combined with institutional controls, as necessary, to meet the remedial action objectives of the ROD;

- as a pilot test will meet the environmental goals intended by landfill closure regulations;
- is as effective as, if not more effective than, the single-barrier cap in achieving the long-term remedial goals for the Site, including a much shorter monitoring and maintenance timeframe;
- has higher implementability;
- and has significantly lower cost.

The vegetative cover will allow the natural succession of native plants and grasses to eventually restore the Site to its pre-remedial action conditions, providing a natural habitat for wildlife and a safe and aesthetically more-pleasing resource for the surrounding community. Future beneficial use of the site may also be achieved by using the vegetative cover environment as an educational center for wildlife and landfills/waste management issues, in conjunction with the Wildlife Habitat Counsel.

Table of Contents

Executive Summary	E-1
1. Introduction	1-1
1.1 Purpose	1-1
1.2 Background	1-2
1.2.1 Site Description	1-2
1.2.2 Hydrogeology	1-3
1.2.3 Environmental Activities	1-4
1.3 Occurrence and Distribution of Constituents of Concerns	1-5
1.4 Summary	1-7
2. Remedial Action Objectives	2-1
2.1 Remedial Action Objectives	2-1
2.2 Feasibility Study Evaluation Criteria	2-2
3. Description of Cover Alternatives	3-1
3.1 Vegetative Cover	3-1
3.1.1 Overview	3-1
3.1.2 Existing Cover Conditions	3-2
3.1.3 Vegetative Cover System Components	3-2
3.1.3.1 Vegetative/Protective Layer	3-2
3.1.3.2 Trees	3-3
3.1.3.3 Gas Management	3-3
3.2 Single-Barrier Cap	3-3
3.2.1 Foundation Layer	3-4
3.2.2 Barrier Layer	3-5
3.2.3 Drainage Layer	3-5
3.2.4 Vegetative/Protective Layer	3-6
3.2.5 Final Grading Plan	3-6
3.2.6 Gas Venting System	3-6

4. Performance Differences Between Cover Alternatives	4-1
4.1 Control of Constituent Migration	4-1
4.2 Erosion Control and Prevention of Direct Contact with Waste	4-4
4.3 Maintenance Requirements	4-5
4.4 Public Safety Risks	4-5
4.5 Beneficial Site Re-Use	4-5
4.6 Stormwater Management	4-6
4.7 Pilot Study and Evaluation of Vegetative Cover	4-7
5. Comparative Analysis of Alternatives	5-1
5.1 Overall Protection of Human Health and the Environment	5-1
5.2 Compliance with ARARs	5-1
5.3 Long-Term Effectiveness and Permanence	5-2
5.4 Reduction of Toxicity, Mobility, or Volume	5-4
5.5 Short-Term Effectiveness	5-4
5.6 Implementability	5-5
5.7 Cost	5-6
5.7.1 Capital Costs	5-6
5.7.2 Operation and Maintenance Costs	5-6
5.7.3 Present-Worth Analysis	5-7
5.8 Support Agency and Community Acceptance	5-7
6. Recommended Alternative	6-1
7. References	7-1
Tables	
5-1 Opinion of Probable Costs for Vegetative Cover System	
5-2 Opinion of Probable Costs for Single-Barrier Cap System	

Figures

- 1-1 Site Location Map, Woodlawn Landfill, Cecil County, Maryland.
- 1-2 Site Map, Woodlawn Landfill, Cecil County, Maryland.
- 1-3 Site Map with Geologic Cross Sections, Woodlawn Landfill, Cecil County, Maryland.
- 1-4 Generalized North/South Geologic Cross Section, Woodlawn Landfill, Cecil County, Maryland.
- 1-5 Generalized East/West Geologic Cross Section, Woodlawn Landfill, Cecil County, Maryland.
- 1-6a Groundwater Elevation Contour Map, Saprolite Monitoring Wells, July 1998, Woodlawn Landfill, Cecil County, Maryland.
- 1-6b Groundwater Elevation Contour Map, Bedrock Monitoring Wells, July 1998, Woodlawn Landfill, Cecil County, Maryland.
- 1-7 Observed Vinyl Chloride Concentrations in Groundwater, November, 1987, Woodlawn Landfill, Cecil County, Maryland.
- 1-8 Observed Vinyl Chloride Concentrations in Groundwater, Saprolite, November, 1990, Woodlawn Landfill, Cecil County, Maryland.
- 1-9 Observed Vinyl Chloride Concentrations in Groundwater, Bedrock, November, 1990, Woodlawn Landfill, Cecil County, Maryland.
- 1-10 Observed Vinyl Chloride Concentrations in Groundwater, Saprolite, March, 1996, Woodlawn Landfill, Cecil County, Maryland.
- 1-11 Observed Vinyl Chloride Concentrations in Groundwater, Bedrock, March, 1996, Woodlawn Landfill, Cecil County, Maryland.
- 1-12 Observed Vinyl Chloride Concentrations in Groundwater, Saprolite, May, 1997, Woodlawn Landfill, Cecil County, Maryland.
- 1-13 Observed Vinyl Chloride Concentrations in Groundwater, Bedrock, May, 1997, Woodlawn Landfill, Cecil County, Maryland.
- 3-1 Approximate Limits of Vegetative Cover System, Woodlawn Landfill, Cecil County, Maryland.
- 3-2 Approximate Limits of Single Barrier Cover System, Woodlawn Landfill, Cecil County, Maryland.
- 4-1 Predicted Vinyl Chloride Concentrations in Saprolite, Year 2001, Vegetative Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.

- 4-2 Predicted Vinyl Chloride Concentrations in Bedrock, Year 2001, Vegetative Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-3 Predicted Vinyl Chloride Concentrations in Saprolite, Year 2006, Vegetative Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-4 Predicted Vinyl Chloride Concentrations in Bedrock, Year 2006, Vegetative Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-5 Predicted Vinyl Chloride Concentrations in Saprolite, Year 2011, Vegetative Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-6 Predicted Vinyl Chloride Concentrations in Bedrock, Year 2011, Vegetative Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-7 Predicted Vinyl Chloride Concentrations in Saprolite, Year 2001, Single-Barrier Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-8 Predicted Vinyl Chloride Concentrations in Bedrock, Year 2001, Single-Barrier Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-9 Predicted Vinyl Chloride Concentrations in Saprolite, Year 2006, Single-Barrier Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-10 Predicted Vinyl Chloride Concentrations in Bedrock, Year 2006, Single-Barrier Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.
- 4-11 Predicted Vinyl Chloride Concentrations in Bedrock, Year 2011, Single-Barrier Cover Alternative, Woodlawn Landfill, Cecil County, Maryland.

Appendices

- A Opportunities for Wildlife Habitat Enhancement at the Bridgestone/Firestone Woodlawn Landfill.

1. Introduction

ARCADIS Geraghty & Miller, Inc. has prepared this Focused Feasibility Study (FFS), on behalf of Bridgestone/Firestone, Inc. (BFS), to evaluate an alternate landfill cover option for the Woodlawn Landfill site (Site) in Cecil County, Maryland (see Figure 1-1). The U.S. Environmental Protection Agency (USEPA) requested this FFS to modify its September 28, 1993 Record of Decision (ROD), which selected a highly engineered single-barrier cap system for the Site. USEPA proposes to authorize a five-year pilot study to confirm that a simpler vegetative cover system will be adequate to achieve the USEPA's environmental protection objectives. This proposal is based primarily on new evidence demonstrating the protective effect of natural attenuation mechanisms, which are projected to achieve the Site cleanup objectives within essentially the same time frame regardless of the cover design employed. Data will be collected throughout the term of the pilot study to document the performance of the vegetative cover and to evaluate the potential need to install the original ROD cover.

Conducting this pilot test is warranted for several reasons. The pilot test can be done without endangering human health or the environment. Extensive data have been collected at the Site demonstrating that groundwater constituents are not migrating to endanger local residents' water supply. The extensive monitoring well network assures that any significant expansion of the zone of affected groundwater would be detected well before it could threaten public health. Knowledge gained during the pilot test will be useful to regulatory agencies in future decision-making at other landfills across the country. Perhaps most importantly, the vegetative cover offers several advantages over the single-barrier cap (including ecological, economic and public safety benefits discussed below) which make the vegetative cover the right technology for this Site.

1.1 Purpose

The main purpose of this FFS is to compare and evaluate the ROD single-barrier cap against the proposed alternate vegetative cover system with respect to attainment of the remedial objectives stated in the ROD, which are as follows:

1. prevent exposure to contaminated groundwater;
2. prevent migration of contaminants from the landfill and polyvinyl chloride (PVC) sludge cells to groundwater and surface water;
3. restore groundwater to its beneficial use;

4. prevent exposure to the contents of the landfill and the PVC sludge cells, and contaminated soils and sediments; and
5. control landfill gas to ensure protection of human health and the environment.

This FFS compares these two cover alternatives using standard USEPA remedy evaluation criteria and concludes that overall, the proposed vegetative cover is better suited to this Site.

1.2 Background

A brief summary of the available background information for the Site is provided below. Detailed descriptions of previous investigations can be found in prior reports (Refs. 1, 2, 3, 4, & 5).

1.2.1 Site Description

The Site is a former municipal landfill located approximately one-half mile north of the Town of Woodlawn and one mile north of the intersection of Routes 275 and 276 in Coloma, Cecil County, Maryland (Figure 1-1). Prior to 1960, the 37-acre property was privately owned and operated as a sand and gravel quarry.

In 1960, Cecil County (County) purchased the property and operated a landfill at the Site. From 1960 to 1978, municipal, agricultural and industrial wastes were reportedly landfilled and sometimes burned at the Site. In June 1978, the landfill was closed to further disposal of municipal waste, although a transfer station has continued to operate in the northeast corner of the Site. A soil cover layer was placed over the landfill after closure. This soil cover, which averages twelve inches in thickness across the Site, has performed with little or no maintenance since closure. No waste is exposed on the surface of the landfill.

Between 1966 and 1981, Firestone Tire & Rubber Company, Inc. (Firestone) was permitted to dispose of sludge from its Perryville, Maryland PVC manufacturing facility. In the later years, this sludge was disposed of in special areas, identified as Cells A, B and C. Because Cell C overlies Cell B, the two cells are referred to together as Cell B/C throughout this document. The approximate locations of Cells A and B/C are shown in Figure 1-2. Early in 1981 Cell B/C was closed by covering with eight inches of clay and two and a half feet of soil in accordance with an agreement with the State of Maryland.

The Site is heavily vegetated, by generally robust deciduous forestland and a mix of herbaceous and scrub/shrub rangeland. In 1992, a small (less than one acre) area of palustrine emergent scrub/shrub wetland habitat was observed in an area originally excavated as a retention basin. An unnamed stream traverses approximately 150 linear feet of the extreme southern portion of the site. The site layout is shown on Figure 1-2.

Roadways have been constructed around the perimeter and over the surface of the landfill to allow access to the site and the monitoring wells. These roadways are maintained to permit unrestricted access to the landfill. Swales and perimeter ditches were installed to capture and transport stormwater runoff to a retention basin located on the south side of the landfill or an unnamed stream in the southwest corner of the landfill. The existing grades of the landfill surface range from 2 to 25 percent and currently promote runoff and minimize any ponding of water on the surface of the landfill.

The Site is located in a rural area dominated by agricultural and residential land use, with other uses such as an abandoned gravel mine and an automobile salvage yard within one mile of the site. Influences from agricultural activities are evident in most of the ecosystems surrounding the Site.

1.2.2 Hydrogeology

The stratigraphy and hydrogeology of the unconsolidated sediments and upper bedrock at the site have been described in detail (Refs. 1, 5, 6, 7, & 8). Generally, the three following stratigraphic units are present beneath the site: (1) unconsolidated sands, gravels, and various landfill materials; (2) saprolite (decomposed bedrock); and (3) bedrock. A line of section map and geologic cross-sections showing the Site stratigraphy are provided as Figures 1-3, 1-4, and 1-5.

Throughout the Site, only the saprolite and bedrock units are saturated with groundwater. The Site receives recharge mainly from precipitation, with a small fraction coming from influx of groundwater from upgradient. Groundwater discharges to perennial streams located along the topographic lows and geologic lineaments (zones of increased weathering). A stormwater retention basin is present in the south-central portion of the site that was reportedly designed to collect runoff from the landfill.

The site is located within a hydrologic flow cell that limits the distance that Site-affected groundwater can flow before being discharged to surface water. The flow cell is defined by the ridge to the northeast of the site, generally along Waibel Road to the

east, along the unnamed creek to the south, and along a topographic low to the west (within the boundaries of the landfill, the topographic low was filled with waste). This hydrologic flow cell is illustrated by Figures 1-6a and 1-6b that depict observed water levels for July 1998.

1.2.3 Environmental Activities

In the summer of 1981, the State initially identified volatile organic compounds (VOCs), including vinyl chloride, benzene, and toluene, in groundwater samples collected from a group of monitoring wells located in the vicinity of Cell B/C. In 1982 numerous additional monitoring wells were installed to assess groundwater quality at the Site. Data collected from these wells indicate the presence of various chemical constituents in groundwater beneath the Site (Ref. 2).

USEPA proposed the Site for inclusion on the National Priorities List (NPL) on January 22, 1987, and placed it on the NPL on July 22, 1987. Two of the Potentially Responsible Parties (PRPs), the County and BFS, entered into an Administrative Order on Consent with USEPA on December 28, 1988, agreeing to perform a Remedial Investigation/Feasibility Study (RI/FS) (Ref. 6) with USEPA oversight, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA).

An additional 13 groundwater monitoring wells were installed during the Remedial Investigation to further characterize and monitor groundwater conditions at various depths beneath the Site. Groundwater samples were collected from wells on the Site and residential wells surrounding the Site. PVC sludge in Cell B/C, soils, leachate seeps and seep sediments, surface water and stream sediments were also sampled and evaluated.

A Baseline Risk Assessment (Ref. 1) was performed in order to evaluate the human health risks and the environmental impacts associated with potential pathways of exposure to chemical constituents from the Site. The risk assessment concluded that groundwater poses the primary exposure risk at the Site, that vinyl chloride presents the greatest potential future carcinogen exposure risk and that manganese presents the greatest potential future noncarcinogenic exposure risk.

The Feasibility Study (FS) for the Site was completed in April 1993 (Ref. 6). The FS evaluated remedial action alternatives for the Site based on then-current understanding of the Site and modeling that predicted extensive vinyl chloride migration in future years if an aggressive remedy was not employed. The FS modeling was performed

without considering the impact of natural attenuation, which was not recognized as a significant factor at the time. Based on the FS evaluations, a proposed Remedial Action Plan (RAP) incorporating Landfill Capping/Groundwater Extraction and Treatment was issued by USEPA on May 26, 1993. The ROD was issued on September 28, 1993.

Since the Site ROD became effective in 1993, predesign investigations have collected new and significant site-specific data showing that natural attenuation mechanisms are causing groundwater constituents to decline or stabilize and not migrate from the landfill (Refs. 3, 5 & 8). In recent years, the level of research and understanding has advanced dramatically in the area of natural attenuation mechanisms. To date, five quarters of biogeochemical groundwater data have been collected using USEPA-approved protocols to confirm and further demonstrate the effectiveness of natural attenuation as the alternative remedy for groundwater. In an August 6, 1997 letter, USEPA stated that it will propose an amendment to the ROD supporting the use of monitored natural attenuation, rather than groundwater extraction and treatment, as the preferred alternative remedy for groundwater at the Site.

The new understanding of the ability of natural attenuation to remediate the groundwater has also prompted a reconsideration of the landfill cover portion of the ROD remedy for the Site. This FFS provides an evaluation and comparison of a vegetative cover and the single-barrier cap systems. The systematic comparison of the cover alternatives indicates that the vegetative cover system is preferred over the single-barrier cap not only in groundwater protection, but also in other relevant respects, including cost-effectiveness, public safety, ecological net benefits and long-term performance and maintenance.

1.3 Occurrence and Distribution of Constituents of Concern

As explained in previous reports, the occurrence and distribution of the most important groundwater constituents of concern (COCs) is governed by natural attenuation mechanisms (Refs. 3, 5 & 9). The foundation for determining the importance of natural attenuation lies in the observed marked decline in concentration and reduced area of primary groundwater constituents detected at the Site. The historical distribution of constituents indicates vinyl chloride and manganese are the most commonly detected and most widely distributed constituents at the site. As such, the occurrence and distribution of these constituents are the predominant factors in defining the area-of-attainment and potential exposure risk associated with the site. The new and significant Site data have demonstrated that these constituents are being reduced and controlled by natural physical and chemical factors at the Site.

The vinyl chloride plume (in both the saprolite and bedrock water-bearing units) continues to shrink. Concentrations in individual wells have fallen by approximately 90 percent since 1987, while the area of the vinyl chloride plume has concurrently decreased (see Figures 1-7 through 1-13). The vinyl chloride plume extends beyond the area of waste-in-place only in small areas at the northern and southern portions of the Site. Both anaerobic and aerobic biodegradation mechanisms are actively degrading the vinyl chloride. The aerobic processes, which are likely the predominant degradation mechanisms, are dependent on the amount of dissolved oxygen in groundwater at the Site. Oxygenated water is received through precipitation recharge, influx of groundwater through upgradient sources, and gaseous diffusion from the atmosphere through the soil surface. The level of oxygenation can be identified by oxidation/reduction potential (redox) measurements in groundwater.

The dissolved manganese in groundwater has apparently stabilized, and is not migrating. An evaluation of historical trends for wells located near and outside the boundary of waste-in-place indicates that manganese concentrations are at least stable in the majority of the wells. Other wells show decreasing trends, while a few wells (located in the oxygen-starved interior of the Site) show increasing trends. (A recent increase in dissolved manganese concentrations observed in some wells may be an artifact of the low flow sampling procedures, which cause less air to be introduced into samples that have been employed since February 1997, especially for wells located in the most reduced portion of the Site plume.)

The occurrence and distribution of manganese is controlled by biogeochemical conditions, especially redox potential, which is strongly affected by the availability of dissolved oxygen. The recently generated biogeochemical data set collected using low-flow sampling techniques indicates that elevated dissolved manganese concentrations can be directly correlated to anaerobic and strongly reducing conditions in groundwater. Therefore, the aerobic and oxidizing conditions that currently exist at the Site, surrounding the area of waste-in-place, are sufficiently controlling the migration of manganese.

The occurrence, fate and transport of constituents of concern other than vinyl chloride and manganese have also been discussed in previous reports (Refs. 3, 5 & 9). Since these other constituents are generally found in low and declining concentrations and since they generally exhibit low mobility in the environment, these other constituents also do not require application of the original ROD remedies.

1.4 Summary

The data collected and interpreted during the predesign investigations comprise significant and new information developed since the ROD for the Site was signed in September 1993. The assumptions regarding constituent distribution, fate and transport that formed the risk basis for the ROD are untenable in light of this new information. In addition, improved understanding of the hydrogeology, groundwater flow patterns and COC fate and transport warrant reevaluation of exposure risks assumed for the ROD. There is an increased understanding of the potential risk to groundwater users posed by the site and the potential effects of landfill capping on groundwater biogeochemical conditions. Also, the advent of a large and growing body of research provides confidence that monitored natural attenuation is an effective remedial approach for site COCs. This increased understanding and knowledge base provide the basis for re-evaluating the landfill cover portion of the remedy in this FFS.

2. Remedial Action Objectives

The National Contingency Plan (NCP) requires that a feasibility study be performed for sites under CERCLA "to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the waste management options can be presented to a decision maker and an appropriate remedy selected." It also requires that, as part of the feasibility study, "the lead agency shall develop one or more innovative treatment technologies for further consideration if there is a reasonable belief that they offer potential for better treatment performance or implementability; fewer or lesser adverse impacts than other available approaches; or lower costs for similar levels of performance than demonstrated treatment technologies."

This section sets out the cleanup goals, or Remedial Action Objectives (RAOs). Information on the cleanup goals permits comparison of the two alternative cover technologies on the most important remedy selection issue: remedial performance.

This section also identifies the standard factors governing remedy selection in feasibility studies. Consideration of factors other than performance is deemed necessary to identify the most appropriate remedy. These standard factors will govern remedy selection when more than one alternative is judged to be sufficient to achieve the remedial objectives.

2.1 Remedial Action Objectives

Remedial Action Objectives are statements in the ROD that specify site remediation goals and identify COCs, media, and exposure pathways that will be addressed by remedial actions. Remedial goals establish exposure levels that are protective of human health and the environment. The RAOs are used in the screening of technologies and in the development and detailed evaluation of remedial alternatives.

According to the ROD, "The overall remedial objectives for the Site are as follows:

- (1) to prevent exposure to contaminated ground water;
- (2) to prevent migration of contaminants from the landfill and PVC sludge cells to ground water and surface water;
- (3) to restore ground water to its beneficial use;

- (4) to prevent exposure to the contents of the landfill and the PVC sludge cells, and contaminated soils and sediments; and
- (5) to control landfill gas to ensure protection of human health and the environment.”

Based on these goals, the following remedial objectives and cleanup levels were developed for groundwater at the Site based on the findings from the Remedial Investigation, Baseline Risk Assessment, and post-ROD predesign investigations:

- (1) Prevent exposure to ground water that contains COCs at concentrations that exceed the cleanup levels presented in Tables 9 and 10 of the ROD, until the ground water cleanup levels are achieved.
- (2) Remediate ground water in the area-of-attainment so that the levels of COCs with carcinogenic health effects do not exceed the ground water cleanup levels presented in Table 9 of the ROD.
- (3) The levels of COCs with noncarcinogenic health effects presented in Tables 9 and 10 of the ROD and revised in ARCADIS Geraghty & Miller's January 1998 letter (Ref. 10) do not exceed a hazard index greater than 1.0 as calculated on a per well basis. As noted in Tables 9 and 10 of the ROD, USEPA will take background levels of arsenic and manganese into account in determining whether the remediation objectives have been achieved.

2.2 Feasibility Study Evaluation Criteria

The USEPA guidance for evaluating remedial alternatives prescribe a set of criteria to be evaluated to determine the effectiveness of each alternative in addressing the impacts to human health and the environment attributed to the COCs at the Site (Ref. 11). Each alternative is evaluated based on the following evaluation criteria:

- Overall protection of human health and the environment,
- Compliance with Applicable or Relevant and Appropriate, Requirements (ARARs)
- Long-term effectiveness and permanence,
- Short-term effectiveness,
- Reduction of toxicity, mobility, or volume,

- Implementability,
- Cost,
- Support agency acceptance, and
- Community acceptance.

The first two criteria are referred to as threshold criteria. The next five criteria are commonly referred to as primary balancing criteria. In combination, these seven criteria make up the major portion of the evaluation. The final two criteria are commonly referred to as modifying criteria. These criteria will be evaluated following completion of the FFS and public review and comment.

3. Description of Cover Alternatives

This section describes in detail the two cover alternatives being evaluated.

3.1 Vegetative Cover

A vegetative cover will provide containment by preventing exposure to the contents of the landfill and PVC sludge cells. Treatment will be achieved by allowing infiltration and oxygen flux to promote the continuation of ongoing natural attenuation of groundwater. Institutional controls will be provided during the period of attainment with a perimeter fence and monitoring to demonstrate the success of natural attenuation. The vegetative cover will achieve the RAOs of the ROD, provide a holistic approach to site remediation, minimize maintenance and costs, and provide permanent effectiveness. As the cover vegetation is allowed to mature, it will provide a natural habitat for local wildlife that currently inhabit the site, and also be more aesthetically pleasing.

The vegetative cover alternative consists of at least 2 feet of vegetated cover soil with a slope of at least 4-percent. Trees existing on the landfill cover will be cleared if soil is required to attain the 2-foot soil thickness or the 4-percent slope. (See Figure 3-1).

3.1.1 Overview

Current conditions at the Woodlawn Landfill permit and enhance natural attenuation of the groundwater and stabilization of the waste (Ref. 5). To sustain continued natural restoration of the aquifer and to meet the other RAOs of the ROD, a vegetative cover is proposed as a remedial alternative at the Site. As supported by the NCP, and compared to the remedy prescribed in the ROD, the vegetative cover alternative offers enhanced waste treatment performance and implementability; fewer or lesser adverse impacts than other available approaches; and lower costs for similar levels of performance than demonstrated treatment technologies. The vegetative cover will prevent exposure to the contents of the landfill and the PVC sludge cells, as required by the RAOs.

Construction of the vegetative cover would include placing additional cover soil as necessary to establish minimum slopes and thicknesses, and establishing and promoting a healthy vegetative cover. Once the initial grading is complete, the restored areas will be seeded with indigenous grasses that promote runoff and are suggested for use in highly erodible areas.

3.1.2 Existing Cover Conditions

The existing soil cover has been in place over the landfill and PVC sludge disposal cells for approximately the last 17 years. The depth of the soil cover across the site ranges from 0.5 to 2 feet, with an average depth of 1 foot (Ref. 8). The soil cover has provided adequate protection of the in-place waste from surface exposure since closure, as indicated by the lack of detectable impacts to the nearby stream. Also, the site is heavily vegetated with grasses, brush, shrubs, and trees except for a few areas that have been cleared and used for access and storage during past investigations.

Approximately 8.5 acres of the landfill area are covered with an oak-hickory forest habitat. The center of the landfill, where the trees have not yet become established, is classified as an old field habitat (Ref. 7). An old field habitat is an abandoned field or disturbed terrestrial habitat with a well established soil base. This type of habitat is characteristic of the beginnings of woodlands with dense clumps of slender trees. Therefore, indications are that conditions at the landfill will promote the continued maturation and sustainability of the forest habitat and the entire landfill will eventually be covered with trees.

Prior to construction, in order to verify the existing thickness of the cover soil on the landfill, sufficient soil test pits will be excavated to the top of waste to determine soil cover needs. This will enable better prediction of the quantity of imported soils required for the construction of the final cover.

3.1.3 Vegetative Cover System Components

3.1.3.1 Vegetative/Protective Layer

The function of the vegetative/protective layer is to promote surface runoff and minimize soil erosion. The intent is to prevent human or environmental exposure to the contents of the landfill and PVC sludge disposal cells, and to prevent the migration of contaminants to surface water receptors.

The areas that require additional cover soil to meet the 2-foot minimum soil thickness and 4-percent minimum slope will be grubbed to prepare the site for additional cover soil. The additional cover soil will consist of locally-available clean soils placed in 8-inch thick loose lifts until the minimum thickness and slopes are established.

Once the initial grading is complete, a 2-inch thick layer of compost will be placed above the new cover soils. This compost will be incorporated into the upper 4 inches of the cover soils by ripping or tilling to create a 4-inch thick layer with sufficient organic content and nutrients to support the growth of vegetation. Alternatively, six inches of topsoil will be placed above the cover soil so that the final protective layer is a minimum of two feet thick, including the existing soils. The vegetative layer will sustain plant growth in the uppermost layer of the cover system to restrict the rate of soil erosion, promote drainage on the cover, and improve the overall appearance of the closed landfill. This layer will also remove a portion of the infiltration via evapotranspiration.

3.1.3.2 Trees

As discussed in Section 3.1.2, a test pit investigation will be conducted to determine which areas will require supplemental cover soil to meet the 2-foot soil thickness. Based on the existing topographic survey, grading will also be performed to provide a minimum 4-percent slope on the cover. The trees in the areas to receive supplemental soil will be cleared. Where a 2-foot soil cover over the waste exists, trees will be allowed to remain and be permitted to continue the process of natural succession in the forested areas. Eventually the native oak-hickory forest, which has been gradually reclaiming the landfill since closure 17 years ago, can be restored.

3.1.3.3 Gas Management

Since the vegetative cover does not incorporate a barrier layer that is impermeable to landfill gases, construction of a gas collection system is not necessary. The minimal remaining amount rate of landfill gas production will diffuse freely to the atmosphere, or be assimilated within the root zone, without harming the cover.

3.2 Single-Barrier Cap

The single-barrier cap functions as a cap over the waste. Capping is a containment technology that isolates the landfill contents and mitigates the off-site contaminant migration through the use of engineered controls. Capping does not contribute to treatment of waste in the way that a vegetative cover does. The area to be capped is listed as 31 acres in the ROD; however, based on the delineation of landfill material and cell boundaries described previously, the actual area to be capped under this alternative is approximately 20.5 acres. Accordingly, this evaluation was prepared based on a 20.5-acre cap (see Figure 3-2). The single-barrier cap will also include

institutional controls such as a perimeter fence to restrict access indefinitely and monitoring to determine the effects on surrounding residential wells.

The major components of a single-barrier cap system, as determined in the Predesign Investigation Report (PDIR) (Ref. 3) and in compliance with the ROD, consist of the following elements, in ascending order:

- Foundation layer (Random Fill)
- Gas Venting Trench System
- Barrier layer
- Drainage layer
- Vegetative/protective layer

Each layer is discussed in greater detail in the following sections.

3.2.1 Foundation Layer

The foundation layer must provide a structurally-stable subgrade to support the overlying cap components and achieve a subgrade configuration that will ensure positive drainage. The minimum depth of the foundation layer is 2 feet, and the maximum slope is 4 percent. This subgrade configuration is accomplished by clearing, grubbing, and proof-rolling, if necessary, the existing cover soil and incorporating this material into the subbase layer. Relatively flat areas are regraded to achieve a minimum 4 percent slope to prevent the ponding of surface-water runoff that could increase infiltration. On-site regraded material is supplemented with off-site common borrow material, as required, to achieve the final contours. This layer will effectively ensure a subbase of uniform strength, demonstrated through proof-rolling, that is adequate for the support of temporary construction equipment and permanently overlying cover components.

The existing cover over the site is composed of between 6 and 24 inches (with an average of 12 inches) of reworked sand and gravel material that contains fines and resembles a silty loam (Ref. 8). The depth of cover across the landfill will be investigated by installing 2 test pits per acre. Each pit will be excavated to the top of waste and the depth of the soil cover reported. Data from this investigation will be used to predict the quantity of imported soils required for the construction of the final cover. It is anticipated that the existing soil cover material will be supplemented with

an average of 12 inches of common borrow (of a similar particle-size distribution) over at least a portion of the site to achieve an acceptable subbase thickness and minimum slope requirements.

3.2.2 Barrier Layer

Overlying the foundation layer is a barrier whose primary function is to deflect the infiltration of precipitation into the waste and to promote lateral drainage along the upper surface of the barrier by diverting percolating water. Through the PDIR alternatives evaluation, a synthetic membrane was selected as the cost-effective barrier layer material for the Woodlawn Landfill (Ref. 3).

A 40-mil linear low density polyethylene (LLDPE) synthetic membrane was selected for this site because of its flexibility, waste compatibility, accepted use, and cost-effectiveness. A non-textured LLDPE was selected over most of the site because of the gentle slopes (i.e., slopes less than 10 percent) that exist. On any portion of the landfill with slopes greater than 10 percent such as the western portion of the site where slopes approach 25 percent, a textured LLDPE was selected. The estimated area requiring textured material is approximately 5.6 acres. The textured LLDPE would also be applied locally on an as-needed basis to increase frictional resistance and, therefore, slope stability.

3.2.3 Drainage Layer

The purpose of a drainage layer is to intercept percolating infiltration that could otherwise collect and build up head on the underlying barrier layer and to induce internal drainage within the cover system. Water that accumulates immediately below the vegetative/protective layer is routed through the permeable drainage layer for release along the perimeter of the cover system. Through the PDIR alternatives evaluation, a geocomposite was selected as the cost-effective drainage layer material for this site (Ref. 3).

The geocomposite would consist of a geonet, which is comprised of two overlapping polyethylene strands wound into a net structure that transmits fluid, sandwiched between two geotextile layers. The geotextile layers provide a protective cushion and also prevent clogging and obstruction of flow into the geonet.

3.2.4 Vegetative/Protective Layer

The function of a protective soil layer is to ensure the integrity of the barrier layer from root and burrowing animal penetration, frost/desiccation damage, and accidental puncture through the application of an adequate thickness of soil material. Furthermore, this layer will eliminate exposure of the synthetic membrane barrier to ultraviolet degradation and preserve the moisture content of subsurface natural materials.

The total thickness of the additional vegetative/protective layer is 24 inches. This layer consists of commonly available, bank-run or other similar material to be used for the foundation layer and which is screened to remove large rocks that may damage the underlying drainage and barrier layers. Four inches of soil capable of establishing and maintaining vegetative growth would be adequate to sustain vegetation at the site; however, in accordance with the ROD, a minimum of 6 inches of soil was specified. This soil is an organic-rich topsoil that overlays the lower 18 inches of bank-run material or may be bank-run material or other common borrow that is amended with an alternative organic-rich material, such as compost. The vegetative layer must sustain plant growth in the uppermost layer of the cover system to limit the rate of soil erosion, assist drainage on the cover, and improve the overall appearance of the covered landfill. This layer will also remove a portion of the infiltration by evapotranspiration.

3.2.5 Final Grading Plan

The final grading plan for this alternative is similar to the existing contours; however, the overall grade is raised approximately 3 feet by the multiple layers composing the cover. Significant regrading will only be required in those areas where less than a 4 percent grade is currently present, primarily in the north-central portion of the site. This area is similar to that requiring regrading for the vegetative cover alternative. Some limited additional grading may be required to smooth slopes and contours to facilitate installation of the synthetic membrane barrier layer.

3.2.6 Gas Venting System

Given the age of the landfill and the advanced degree of waste degradation with respect to the gas generation rates, an active gas-venting system is unnecessary. Based on calculations to estimate the rate of expected gas generation from the landfill, a passive gas collection system has been designed to collect and vent landfill emissions from beneath the low permeability barrier layer. This will reduce the potential for

gases to accumulate under the cap that can cause an explosion or fire at the site and which may damage the integrity of the cap. The passive gas system will consist of a header system and twelve surface vents. The three header pipes are trenched beneath the foundation layer 1-foot into the waste and placed in gravel with a minimum hydraulic conductivity of 1×10^{-2} cm/sec. The header pipes run parallel in a north-south direction across the landfill and are spaced approximately 300 feet apart, a distance calculated as sufficient for maintaining gas pressures below 16 psf. Four-inch diameter perforated, corrugated, polyethylene pipe is utilized for the piping system. The vents will extend approximately 3 feet above ground surface. If gas generation rates were to exceed the capacity of the surface vents, supplemental passive gas venting wells would be installed along the header pipe system to increase the capacity of the passive gas collection system.

4. Performance Differences Between Cover Alternatives

4.1 Control of Constituent Migration

Two important functional differences exist between the vegetated cover and the single-barrier cap that affect each system's ability to contribute to meeting the groundwater cleanup objectives. First, the single-barrier cap is more effective than the vegetative cover in restricting precipitation infiltration into the waste, particularly in the initial period before trees become established across the cover. Lower amounts of infiltrating precipitation are typically considered more favorable in terms of restricting constituent migration, since the generation of leachate is minimized. Second, the vegetative cover is far more permeable to oxygen than is the single-barrier cap. Oxygen migration into the fill material and the groundwater is important, if not essential, to maintenance of the natural attenuation mechanisms that are currently degrading vinyl chloride and immobilizing manganese.

The impact of future infiltration through the landfill cover on the quality of groundwater beneath and downgradient of the Site has been assessed using the three-dimensional groundwater flow and transport model that was developed to support natural attenuation as an alternative to the ROD-prescribed groundwater pump and treat remedy. The details of the model are described in the Focused Feasibility Study/Groundwater Remedy (Ref. 5).

The performance of the vegetated cover was evaluated by simulating the fate of vinyl chloride using the calibrated transport model, and assuming infiltration rates based on the current cover conditions. This modeling approach is conservative, because it overestimates infiltration somewhat. The grading plan of the vegetative cover will be an improvement over existing conditions in only a limited area, while the addition of an average of 1 foot of cover soil will only marginally reduce the infiltration rate through the cover. Also, no account is taken of expected reductions in infiltration that will occur as trees colonize the cover. A similar modeling of the single-barrier cap performance was undertaken using much lower infiltration rates calculated for the single-barrier cap design using the HELP model (Ref. 4).

The simulations were evaluated using the March 1996 observed vinyl chloride concentrations as initial conditions (see Figures 1-10 and 1-11). Existing levels of domestic pumping were assumed for the simulations. Two additional simulations were performed to evaluate the effects of future concentrated residential development in the vicinity of the Site.

The output of the simulations were examined to estimate the time at which vinyl chloride concentrations are projected to achieve the remedial objective of 1 part per

billion (ppb). While that the ability of groundwater transport models to precisely predict the time of attainment of cleanup levels is limited, groundwater modeling, as applied at the Woodlawn Landfill, is useful to compare the relative time frame for attainment of cleanup objectives for various remedial approaches.

Using either the current infiltration rate or the infiltration rate appropriate for a single-barrier cap, vinyl chloride concentrations are predicted to decrease from 1996 levels under current conditions and each future residential development scenario. The simulations indicate that the concentrations of vinyl chloride will decline to levels below the RAO of 1 ppb by approximately the year 2011 (see Figures 4-1 through 4-11). The modeling predicts that existing or potential future domestic wells in the vicinity of the site will not be impacted for any of the remedial or future development scenarios. Based on the fate and transport modeling results, future domestic wells in any other region will not be impacted by vinyl chloride from the landfill. Recent water quality data collected in 1997 utilizing low-flow sampling techniques indicate continued site-wide concentration declines and validate the model predictions.

Thus, fate and transport modeling indicates that infiltration rate differences between the vegetative cover and the single-barrier cap do not materially change the time at which the groundwater cleanup objective for vinyl chloride is achieved. The model is calibrated, however, to degradation rates observed under conditions of relatively free influx of water and oxygen to the subsurface. There is a possibility that reductions in these influxes caused by installation of a single-barrier cap could substantially retard the degradation rates and slow the rate of cleanup.

Retardation of natural attenuation mechanisms under the single-barrier cap is anticipated based on the current understanding of aerobic degradation mechanisms and based on observations at this Site. Aerobic oxidation is the fastest natural attenuation mechanism for the degradation of vinyl chloride. Therefore, available dissolved oxygen present within the plume is an important factor in the assimilative capacity of the aquifer for vinyl chloride. Groundwater sampling data collected in March, May, August, and November 1997 indicate an inverse correlation of vinyl chloride concentrations to dissolved oxygen content in groundwater: vinyl chloride is not present in groundwater that contains dissolved oxygen in the aerobic range.

Data from wells located along the landfill perimeter indicate that concentrations of manganese in the area-of-attainment are declining with time via natural attenuation mechanisms. While naturally-present manganese may be dissolving within the more anaerobic, highly-reduced portions of the landfill interior, it is evidently precipitating once it has migrated to portions of the aquifer where aerobic conditions exist. Continuous replenishment of oxygen into the impacted areas is therefore advantageous in maintaining the observed degradation of vinyl chloride and raising the redox

potential. Raising the redox potential will also enhance the geochemical environment within the plume to revert back to the background conditions at a faster rate. The vegetative cover system, which allows the maximum infiltration of oxygen-rich water into the plume, will facilitate this ongoing monitored natural attenuation remedy.

The shrinkage of the vinyl chloride plume indicates that any leachate being generated is assimilated before it can threaten potential receptors, and the current knowledge of natural attenuation mechanisms indicates that the process is oxygen-driven. Oxygen is currently transported into the Woodlawn Landfill through precipitation recharge, influx of groundwater from upgradient sources, and gaseous diffusion from the atmosphere through the soil surface. Each of these pathways was evaluated in detail in the Final Design Report [for the] Landfill Cover System (Ref. 4). Precipitation recharge transfers about 400 pounds of oxygen per year into the landfill. The lateral inflow of groundwater from upgradient sources is a minor contributor because the landfill is located in the upgradient portion of the local flow system, and the water supply well at the waste transfer station is between the landfill and upgradient recharge areas, thereby reducing the available flow. Oxygen transport from lateral groundwater inflow was computed to be only about 13.5 pounds per year. The primary mechanism transferring oxygen into the landfill is diffusion into the soil from the atmosphere. As summarized by Nyle Brady (Ref. 12),

"the exchange of gases between the soil and the atmosphere . . . is facilitated by two mechanisms: mass flow and diffusion. Mass flow of air, which is due to pressure differences between the atmosphere and the soil air, is less important than diffusion in determining the total exchange that occurs. It is enhanced, however, by fluctuations in soil moisture content. As water moves into the soil during a rain . . . air will be forced out. Likewise, when soil water is lost by evaporation from the surface or is taken up by plants, air is drawn into the soil. Mass flow is also modified slightly by other factors such as temperature, barometric pressure, and wind movement. Most of the gaseous interchange in soils occurs by diffusion."

Brady estimated the minimum rate of oxygen diffusion at the bottom of the root zone to be 5×10^{-8} grams per centimeter squared per minute, or 2,340 pounds per year per acre. Over the surface of the landfill, this translates into 48,000 pounds of oxygen per year into the landfill, which facilitates the stabilization of the waste. By contrast, the single-barrier cap would admit only an estimated 51 pounds of oxygen or about a tenth of one percent of the influx that is currently supporting the aerobic natural attenuation mechanisms. The natural attenuation process is not sufficiently understood such that the effects of incremental change in parameters can easily be quantified. However, this tremendous reduction in oxygen loading is expected to have an adverse effect on the degradation and stabilization of the waste and the natural attenuation of the vinyl

chloride dissolved in groundwater. The resultant reduction in the natural attenuation rate for vinyl chloride would likely cause dissolved vinyl chloride to be more persistent and may actually increase the rate of contaminant influx to groundwater due to reduced natural attenuation in the waste. Further, the time for achievement of the RAOs could be extended.

The vegetative cover will allow the maximum rate of oxygen flux into the groundwater through the surface of the landfill, and experience at the site demonstrates that continued infiltration is not detrimental to the attainment of the groundwater cleanup objectives. Therefore the vegetative cover performance is most supportive of continued natural attenuation and ultimate restoration of the aquifer.

4.2 Erosion Control and Prevention of Direct Contact with Waste

Since both cover alternatives include substantial vegetated surface layers, erosion and sediment production rates are not expected to be significant for the installed covers. Maintenance of these covers will assure that waste will not surface and be a source of direct contact or airborne exposure. Current site conditions indicate no erosion rills or channels, and no exposed waste due to wind or stormwater runoff. The amount of erosion and sediment production was quantified using the Universal Soil Loss Equation for two scenarios: (1) a vegetative cover with the trees cleared and (2) a vegetative cover with the trees remaining (Ref. 3). According to these results, no permanent erosion and sediment control measures are necessary in either situation. If the trees are not cleared, the erosion rate was calculated to be approximately 0.1 tons/acre/year subsequent to the establishment of vegetation on the restored areas. If the trees are cleared, the erosion rate was calculated to be approximately 0.2 tons/acre/year subsequent to the establishment of vegetation. As the vegetative cover system evolves toward a forest community, the erosion rate is expected to decline, whereas for the single-barrier cap system, which maintains essentially the same susceptibility to erosion in perpetuity, the erosion potential will not decline from the 0.2 ton/acre/year rate.

The amount of erosion and sediment production during the construction of the vegetative cover system is significantly less than that produced for the single-barrier cap alternative for several reasons. It is likely that the area requiring additional soil for the vegetative cover is less than the area of the single-barrier cap. The slopes of the vegetative cover will likely be less steep, since the vegetative cover will require less additional soil than the single-barrier cap. Also, the construction will therefore require less time than the single-barrier cap construction.

4.3 Maintenance Requirements

The vegetative cover system will require very limited maintenance to ensure that a permanent vegetative stand is established in the first full growing season. The seed mixture is selected in conjunction with the Cecil County Soil Conservation Service to incorporate components of the existing native cover which does not require mowing or irrigation, and represents the end-stage natural vegetation in the area until trees are established. Following the first season, maintenance is limited to annual inspections to identify excessive settling that may cause ponding and erosion channel development that could expose waste. The vegetative cover has only one layer to be maintained, as opposed to the multi-layered single-barrier cap; therefore, any potential problems that would require repair would be obvious in a visual inspection, such as ponding, erosion rills, and stressed vegetation, and would be readily restored. These issues would not be indicative of an underlying problem requiring excavation into the vegetative cover to discover the cause or other further investigation. This one-layer maintenance requirement minimizes potential threats to the function of the cover system and fosters routine maintenance.

4.4 Public Safety Risks

The location of the Woodlawn Landfill in a rural-residential setting reduces the potential for high incidences of unauthorized site access. However, one short-term concern that will arise during construction of this cover system is the risk to the surrounding neighborhoods created by hauling soil and other building materials to the site. The roads surrounding the site are narrow, do not have shoulders, and are lined with residences in every direction. The risk posed by the trucks hauling materials to the site may well exceed any risks currently posed by the site. Public safety risks associated with hauling of materials would be larger for the single-barrier cap than for the vegetative cover because larger amounts of imported soils and other materials are required to construct the single-barrier cap.

4.5 Beneficial Site Re-Use

The minimal site construction that would be required to install and maintain the vegetative cover expedite site stabilization and limit disruption of the current habitat for local wildlife. Clearing of the existing stands of trees and ground cover around the perimeter of the site is minimized. Remaining trees will intercept dispersing airborne particles to create a natural noise barrier, screen the view from neighbors, and provide a windbreak. Because no barrier layer is incorporated into the vegetative cover system, this design is compatible with beneficial natural reforestation of the cover area.

By contrast, installation of a single-barrier cap would limit the options for future beneficial use of the Site. The currently established habitat for wildlife in the Site vicinity would be more greatly disturbed because the existing stands of trees and ground cover around the perimeter of the Site would be removed to outside the limits of waste placement. This removal would result in a significant reduction of, and in some cases, the complete removal of the natural barrier between the Site and surrounding residences. Because this alternative includes a synthetic membrane barrier layer, natural reforestation is not possible because the tree roots would damage the barrier system; a grassy condition will, therefore, need to be maintained forever. Active reuse of the Site will also be limited, unless planned and incorporated into the remedy. The cover system could be susceptible to penetration from any surface activities, resulting in contact with waste that would not be decomposed, as water and oxygen infiltration would have been shut off.

A potential beneficial use for the Site, particularly under the vegetative cover alternative, is the establishment of a wildlife and landfill educational center, as well as a wildlife enhancement program in conjunction with the Wildlife Habitat Council (WHC). BFS is working with the WHC regarding a future program for management of wildlife and habitat diversity at the site while educating the public regarding landfill management and environmental awareness. With the focus on environmental enhancement and waste management, this project could be combined with a campaign to increase recycling in the area as well. The WHC has prepared a report entitled *Opportunities for Wildlife Habitat Enhancement at the Bridgestone/Firestone Woodlawn Landfill* (see Appendix A). BFS intends to foster communications between the County, Maryland Department of the Environment (MDE) and USEPA, with the objective of working with WHC to implement these concepts.

4.6 Stormwater Management

In general, the final grades of both cover systems will mimic the existing topography except at the crown of the landfill where currently flatter grades will be increased to 4 percent. The minimum slope for the entire landfill area will be 4 percent. Pre- and post-development stormwater runoff quantities for these covers were calculated using the Soil Conservation Service Technical Release 55 (SCS TR-55) Computer Model - Urban Hydrology for Small Watersheds (Ref. 3). Runoff quantities were calculated for the following design storm events:

- 2-year, 24-hour recurrence interval;
- 10-year, 24-hour recurrence interval; and,
- 25-year, 24-hour recurrence interval.

The peak runoff from the landfill for the design storm events were calculated using the Tabular Hydrograph Method.

The difference in the volume of runoff from each drainage area under the pre- and post-development conditions for the 2-year design storm was used as the criterion for requiring stormwater management and/or the type of stormwater management control structures. If the calculated peak runoff during the post-development conditions results in less than a 10 percent increase in runoff compared to that calculated for the pre-development (i.e., current) condition, no additional permanent stormwater controls are warranted or necessary for the site. The runoff resulting from the 10-year and 25-year design storm events were used to size control features.

The post-development runoff for the 2-year design storm for the vegetative cover system alternative with trees resulted in no increase in runoff from any of the three drainage areas for the Site. Therefore, new stormwater management controls will not be necessary if no trees are cleared. If all trees are cleared under the vegetative cover system alternative or if the single-barrier cap system were to be implemented, there would be an effective increase of more than 10 percent in one of the three drainage areas.

In the long-term, the vegetative cover would be expected to evolve to a forested condition that would actually reduce stormwater runoff rates from current levels, which will constitute an overall benefit to the watershed. The design of stormwater management controls will be determined by cover system components and grading.

4.7 Pilot Study and Evaluation of Vegetative Cover

The vegetative cover is proposed as a 5-year pilot study. If the pilot study evaluation demonstrates that the vegetative cover allows natural attenuation to continue to restore the aquifer to beneficial use, the vegetative cover will remain as a permanent solution.

A monitoring program has been designed to demonstrate natural attenuation, consistent with the intent of USEPA guidance and technical protocols published by the U.S. Air Force (Refs. 13 & 14) for long-term compliance monitoring practices and RAOs and guidance for the Woodlawn Landfill discussed in this FFS. The purpose of the long-term groundwater monitoring plan is to document that the natural attenuation mechanisms that are currently effective in attenuating COCs in groundwater at the Site continue, to ensure that cleanup levels are achieved, and protection of human health and the environment is continued. The May 21, 1998 Long-Term Groundwater Monitoring Plan was conditionally approved by USEPA on June 29, 1998, and the Revised Long-Term Groundwater Monitoring Plan, in compliance with the conditions, was submitted to USEPA on July 14, 1998 (Ref. 15).

Five quarters of groundwater data have been collected to date as part of the Long-Term Groundwater Monitoring Program, and quarterly monitoring will continue throughout the five-year pilot study. To ultimately demonstrate final attainment of the RAOs, in accordance with the Revised Long-Term Groundwater Monitoring Plan, the quarterly long-term groundwater monitoring data collected will be evaluated with statistical methods consistent with USEPA guidance (Ref. 16) to determine if measured concentrations are below the cleanup standard. Data will also be analyzed to ensure that statistically decreasing trends continue, and no increasing trends are discovered that indicate imminent threat to human health or the environment.

If the five-year statistical review demonstrates that groundwater concentration trends continue toward remediation goals, it will be determined that the vegetative cover is an appropriate cover alternative for the groundwater remedy at the Woodlawn Landfill, and will remain as the permanent landfill cover. If the five-year statistical review demonstrates that statistically increasing trend(s) exist that may threaten groundwater users, construction of the USEPA-approved single-barrier cap system will be the presumptive contingency remedy to the vegetative cover. Prior to implementing the presumptive remedy, other remedies will also be evaluated in a focused feasibility study which will address the specific identified imminent threat to human health or the environment.

5. Comparative Analysis of Alternatives

This section evaluates the remedial alternatives according to the feasibility study remedy evaluation criteria identified above in Section 2.2.

5.1 Overall Protection of Human Health and the Environment

This evaluation criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. A review of each of the pathways by which human health and the environment could be impacted shows that the proposed vegetative cover remedy is at least equally protective as the barrier cover remedy required by the ROD. Both alternatives minimize erosion and promote runoff. Both alternatives remove COCs from the groundwater. Both alternatives prohibit contact with the underlying landfill contents, and both alternatives would achieve cleanup levels within a similar time frame according to the groundwater modeling. There is a significant possibility, however, that the single-barrier cap, by blocking the migration of oxygen to the subsurface, would actually delay achievement of the groundwater cleanup objectives.

5.2 Compliance with ARARs

Section 121(d) of the Superfund Amendment and Reauthorization Act (SARA) and the NCP require that remedial actions under CERCLA comply with all federal Applicable or Relevant and Appropriate Requirements, or ARARs. State requirements must also be considered under Section 121(d)(2)(c) of SARA if they are legally enforceable and consistently enforced statewide. Under Section 121(d)(4) of SARA, requirements may be waived by the USEPA under specific conditions, provided that protection of human health and the environment is still assured.

ARARS may include the following:

- Any standard, requirement, criterion, or limitation promulgated under federal environmental law, and
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

“Applicable” requirements are promulgated cleanup standards, standards of control, or other substantive environmental criteria, or limitations. In other words, these are legal requirements specifically applicable to the site. These requirements specifically

address a hazardous substance, a remedial action, a location, or other site-specific condition.

“Relevant and appropriate” requirements are federal and state standards, criteria, or limitations that are not legally applicable to the project, but which may address problems sufficiently similar to those found.

There are no regulations applicable to the design of the cover for this Site. Both cover alternatives comply with Maryland regulations that could be considered “relevant and appropriate”, with one exception. The vegetative cover does not include a low permeability layer or a drainage layer. However, it is not clear that it is appropriate to apply the Code of Maryland Annotated Regulation (COMAR), which is applicable to a newly closed landfill, to a landfill that has been closed for more than seventeen years. Additionally, COMAR 26.04.07.03.A states, “A person may not engage in solid waste handling in a manner which will likely . . . impair the quality of the environment or create other hazards to the public health, safety or comfort as may be determined by the Approving Authority.” The vegetative cover is an alternative proposal that achieves the intent of the State’s design requirements, which is the protection of groundwater and air quality, while preventing direct exposure to waste. The vegetative cover allows ongoing natural attenuation mechanisms to continue to degrade and/or stabilize COCs and restore the groundwater to its beneficial use. In the specific case of the Woodlawn Landfill, construction of a final cover in compliance with COMAR could interfere with the natural attenuation mechanisms currently cleaning up the groundwater. With the support of this engineering analysis, a vegetative cover is an appropriate technology to implement as a pilot study to meet the environmental goals intended by COMAR. Compliance with ARARs may be re-evaluated at the completion of the pilot study.

5.3 Long-Term Effectiveness and Permanence

This evaluation criterion addresses the results of a remedial action in terms of its permanence and the quantity/nature of waste or residual levels of contamination remaining at the Site after the RAOs have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the residual levels of COCs remaining at the Site.

Both alternatives would permanently remove COCs from the aquifer that underlies the Site, while containing waste-in-place. The magnitude of residual risk, though, could be higher with the single-barrier cap, as it would slow the degradation process, possibly preventing the complete stabilization of the waste. Therefore, if the cover should fail, there could be an environmental exposure to partially decomposed waste.

While this is a relatively small risk, allowing the waste to further decompose under the permeable vegetative cover does provide an advantage in this respect.

Maintenance requirements for the single-barrier cap system are much greater than those required for the vegetative cover alternative. The vegetative cover is a natural, holistic remedy that will work with the surrounding environment to promote natural attenuation of groundwater contaminants while allowing waste to decompose. Any disruption of the vegetative cover would be apparent during visual inspections. For instance, surface ponding, erosion gullies, and stressed vegetation are typical problems that would require maintenance and each are detectable through a visual inspection.

Potential problems with the single-barrier cap system are not always as apparent. For instance, if surface ponding is observed, the cause may be settling of the underlying synthetic membrane and drainage layer. This would compromise the function of the drainage layer and ultimately the synthetic membrane. An ensuing subsurface investigation would therefore be required. Repair of geosynthetics in a single-barrier cap system holds greater risks than the typical reseeding and erosion repair that may be necessary for a vegetative cover. In addition, the outlet of the drainage layer for the single-barrier cap will require perpetual maintenance to ensure that this layer maintains proper flow capacity. Clogging of the drainage layer could cause detrimental effects to the overlying cover soil and vegetation through head build-up.

A single-barrier cap will require perpetual maintenance to maintain a healthy stand of grass. Routine maintenance is required to ensure that trees do not infiltrate onto the landfill footprint because the roots would damage the synthetic membrane through penetration. Under the vegetative cover remedy, native trees and grasses will eventually take over and reduce requirements for maintaining healthy vegetation.

The vegetative cover will naturally vent any future gas generation at the landfill, which will be minimal. Methanotrophs (methane-reducing bacteria) within the root zone of the vegetation can also serve to assimilate some of the landfill gas, producing a net reduction in total emissions. The single-barrier cap requires gas vents to be installed so that gas does not accumulate beneath the impermeable synthetic membrane. The natural venting system of the vegetative cover will function throughout the life of the cover without fail. The landfill has naturally and successfully vented landfill gasses to the atmosphere with no detected adverse effects to air quality for the past 17 years since closure. Conversely, the gas venting system of the single-barrier cap will concentrate gas before it is diffused into the atmosphere, requiring continual monitoring. This system also has the potential to fail in the future, which could cause detrimental effects to the cover system and local air quality.

5.4 Reduction of Toxicity, Mobility, or Volume

This evaluation criterion assesses the ability of the remedial alternative to permanently and significantly reduce toxicity, mobility, or volume of the COCs. The COCs beneath the landfill have been monitored extensively for the last 10 years and are clearly documented to be decreasing in magnitude and extent. This natural remediation of the Site has occurred under existing conditions and will continue after the vegetative cover has been constructed. The natural attenuation processes responsible for the remediation of COCs are driven by the influx of clean water and oxygen into the waste-in-place and the groundwater. At the current phase in the life cycle of the Woodlawn Landfill, waste degradation is nearing completion, methane generation has fallen to minimal levels, and the waste has consolidated well (subsidence has not been noted since the inception of the RI/FS).

Recent investigative work at the Site to determine the thickness of the existing cover indicated the waste currently has the consistency of a thick organic soil mixed with nondegradable plastics. If the single-barrier cap were constructed at the Site, the continued degradation of constituents and stabilization of the waste would virtually stop. The influx of clean water and oxygen would stop and the waste would be entombed, possibly creating management problems for future generations. The data collected at the Site indicate that a vegetative cover will be more effective at reducing the toxicity, mobility, and volume of the waste than would be a single-barrier cap.

5.5 Short-Term Effectiveness

This evaluation criterion assesses the effects of the alternative during the construction and implementation phase, and until the RAOs are met. Under the criterion, alternatives are evaluated with respect to their effects on human health and the environment primarily during construction of the remedial action.

Both alternatives would provide short-term protection of residents who use groundwater from the local aquifer by providing institutional controls (groundwater monitoring, deed and groundwater use restrictions, provision of an alternate water supply if necessary, and a chain-link fence around the Site) until cleanup levels are attained. The single-barrier cap system, however, would require over three times as much soil fill, and implementation of the single-barrier cap system would increase risks to the surrounding neighborhoods during construction created by hauling fill materials to the Site. The roads surrounding the Site are narrow, do not have shoulders, and are lined with residences in every direction. The risk posed by the trucks hauling soil to the Site may well exceed the risk currently posed by the Site;

therefore reducing the fill volume may be the most effective step that can be taken to reduce overall site risks.

The single-barrier cap will require complete site clearing, which will permanently eliminate habitats for several bird, mammal, reptile and amphibian species reported at the Site (Ref. 7). If the forested area remains undisturbed under the vegetative cover alternative due to sufficient cover soil in this area, disruption of these habitats will be minimized, and would come mainly from noise and dust during construction.

5.6 Implementability

This evaluation criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation.

Both alternatives are technically and administratively feasible. Services and materials for both alternatives are readily available. The vegetative cover alternative relies on the natural treatment process occurring beneath the ground surface with minimal engineered intervention and does not pose any exposure or risk of adverse impacts related to operation. From a technical standpoint, the measure of implementability for the alternatives becomes directly related to the amount of site work required to complete the construction. The less site work required, the more constructable the alternative. As presented previously, the vegetative cover alternative is able to achieve the objectives with the least disruption to the Site and surrounding neighborhood habitats.

Quality assurance/quality control requirements for installation of the geosynthetic materials in the single-barrier cap far exceed those of the vegetative cover. There is a much greater possibility of error when placing and seaming geosynthetics for the purpose of hydrologic control. Manufacturing and construction errors can compromise the purpose of the single-barrier cap system, while there are no synthetic materials in the vegetative cover, and the possibility for construction error is minimized.

Construction time for the vegetative cover will be less than one-half of that required for the single-barrier cap since no geosynthetic seaming will be required, less imported soil is required, and less clearing will likely be required. The vegetative cover requires less specialty skills than the single-barrier cap (i.e. geosynthetic seaming); therefore, more qualified contractors will be available to perform the work, and it is more likely that a local contractor will participate in the construction and operations and maintenance. This would add benefit to the community by creating jobs locally.

A measure of implementability includes the ability to monitor the effectiveness of the remedy. The single-barrier cap and vegetative cover share the goals of minimizing erosion and promoting runoff. Where the alternatives' goals differ is that the single-barrier cap aims to minimize infiltration into a landfill, while the vegetative cover supports natural attenuation through oxygen influx. Natural attenuation will be monitored through the monitoring program discussed in Section 4.7. It is possible to measure the effectiveness of the single-barrier cap in minimizing infiltration with lysimeters and time domain reflectometry, although this typically is not done for landfill closures. These methods, because they are infrequently used, are less standardized and possibly less reliable than laboratory analytical methods used to measure the concentrations of contaminants in groundwater.

5.7 Cost

ARCADIS Geraghty & Miller has developed opinions of costs for capital and Operations and Maintenance (O&M) for each alternative to use as a basis for comparison in the evaluation of alternatives. Details regarding the development of these cost opinions for each alternative are included in Tables 5-1 and 5-2.

5.7.1 Capital Costs

Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering and other services that are not part of actual installation activities, but are required to complete the installation of remedial alternatives.

- The estimated capital cost of the vegetative cover is \$1,360,000.
- The estimated capital cost of the single-barrier cap is \$3,430,000.

5.7.2 Operation and Maintenance Costs

Annual O&M costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. Such costs include occasional reevaluation of the site during and after remedial efforts have been implemented. Although the schedule for reevaluation of a site during and after remediation is determined on a case-by-case basis, for the purposes of this study, it has been assumed that the site will be reevaluated every 5 years until completion of the remediation.

The single-barrier cap has a higher risk for unscheduled maintenance costs. These costs can be associated with the investigation and repair of the multiple cap layers, which are susceptible to damage. These costs are difficult to quantify since they are unscheduled, so they are not included in the O&M cost opinion for the single-barrier cap. However, in order to maintain the cap at its intended efficiency, these costs can be significant.

- The estimated annual O&M cost of the vegetative cover is \$40,000.
- The estimated annual O&M cost of the single-barrier cap is \$45,000.

5.7.3 Present-Worth Analysis

A present-worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. For this evaluation, a discount interest rate of 5 percent has been assumed.

- The estimated present worth of the vegetative cover alternative is \$1,970,000.
- The estimated present worth of the single-barrier alternative is \$4,120,000.

5.8 Support Agency and Community Acceptance

The single-barrier cap system final design has been approved by the USEPA, and the concept was not opposed by the community during the ROD development. The schedule mandated by the USEPA Administrative Order (Ref. 17) to implement the response action decided by the ROD has been suspended to allow the completion and consideration of this FFS to amend the ROD. This suspension is a result of USEPA acceptance that the concept of a vegetative cover may be more effective and appropriate for the Site, based on new knowledge showing that the groundwater plume is static or receding. State and community acceptance will be demonstrated when a ROD amendment is proposed, and comments on the FFS and proposed ROD amendment are received.

6. Recommended Alternative

As a result of a thorough analysis of the two focused remedial alternatives currently under consideration for the Woodlawn Landfill, it is recommended that the vegetative cover be implemented on a pilot-test basis. This alternative is expected to satisfy the RAOs, is expected to exceed the single-barrier cap in remedial performance, and is superior to the single-barrier cap on most of the USEPA criteria for remedy evaluation in feasibility studies.

Rather than providing stagnant containment with a single-barrier cap, the vegetative cover will foster natural attenuation processes that will continue to actively treat waste and groundwater, while proving effectively mitigating any groundwater exposure risk and achieving the RAOs. The soil cover of no less than 2 feet will provide protection from contact with the underlying wastes at the Site, and the vegetated surface with a slope of 4 percent or more will minimize erosion and promote runoff to ensure a stable and functional cover for the landfill. The cover will be comprised of all natural materials that will allow the natural succession of native plants and grasses to eventually restore the Site to its pre-remedial action conditions. Thus it will provide a natural habitat for the local wildlife and a safe and aesthetically pleasing resource for the surrounding community. A potential beneficial use for the site, fostered by the vegetative cover alternative, is the establishment of a wildlife and landfill educational center, as well as a wildlife enhancement program in conjunction with the WHC.

Historical and recently-collected data demonstrate that natural attenuation is effective in both containing further migration of COCs from the Site and in reducing the concentrations of COCs in the area-of-attainment and the waste management area. A vegetative cover will promote these ongoing processes. Natural hydraulic controls and continual natural attenuation mechanisms will reduce the toxicity, mobility, and volume of the COCs in groundwater. Extensive monitoring of groundwater and surface water, as necessary, will provide a reliable means of confirming the ongoing effectiveness of the vegetative cover.

Compared to the ROD-prescribed remedy for the Site, a vegetative cover:

- will pose less short term risks to human health and the environment;
- will be combined with institutional controls, as necessary, to meet the RAOs of the ROD;
- is as effective as, if not more effective than, the single-barrier cap in achieving the long-term remedial goals for the Site;
- has higher implementability;
- and has significantly lower cost.

In summary, a vegetative cover is equal to or superior to the ROD-prescribed remedy on all measures of remedial performance, and is implementable at a far lower present-worth cost. Thus, the selection of a vegetative cover is well supported as the appropriate cover alternative at the Woodlawn Landfill.

7. References

References may be obtained at the USEPA Region III offices (1650 Arch Street, Philadelphia, Pennsylvania) by contacting the USEPA Remedial Project Manager or at the Langhorne, Pennsylvania offices of ARCADIS Geraghty & Miller, Inc. (3000 Cabot Boulevard West, Suite 3004).

1. IT Corporation 1992. Remedial Investigation Including Baseline Risk Assessment Report, Woodlawn Landfill Site RI/FS, Cecil County, Maryland (Revision 01), October 26 (approved final by USEPA 11-30-92).
2. United States Environmental Protection Agency 1993. Record of Decision, Woodlawn Landfill Site, September 28, 1993.
3. Geraghty & Miller 1997. Predesign Investigation Report and Feasibility Study Addendum, Woodlawn Landfill Site, Cecil County, Maryland, February 28, 1997.
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6. IT Corporation 1993. Feasibility Study, Woodlawn Landfill RI/FS, Cecil County, Maryland.
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10. ARCADIS Geraghty & Miller 1998. Revised Cleanup Objectives for Noncarcinogens, Woodlawn Landfill Site, Remedial Design/Remedial Action, January 12, 1998.

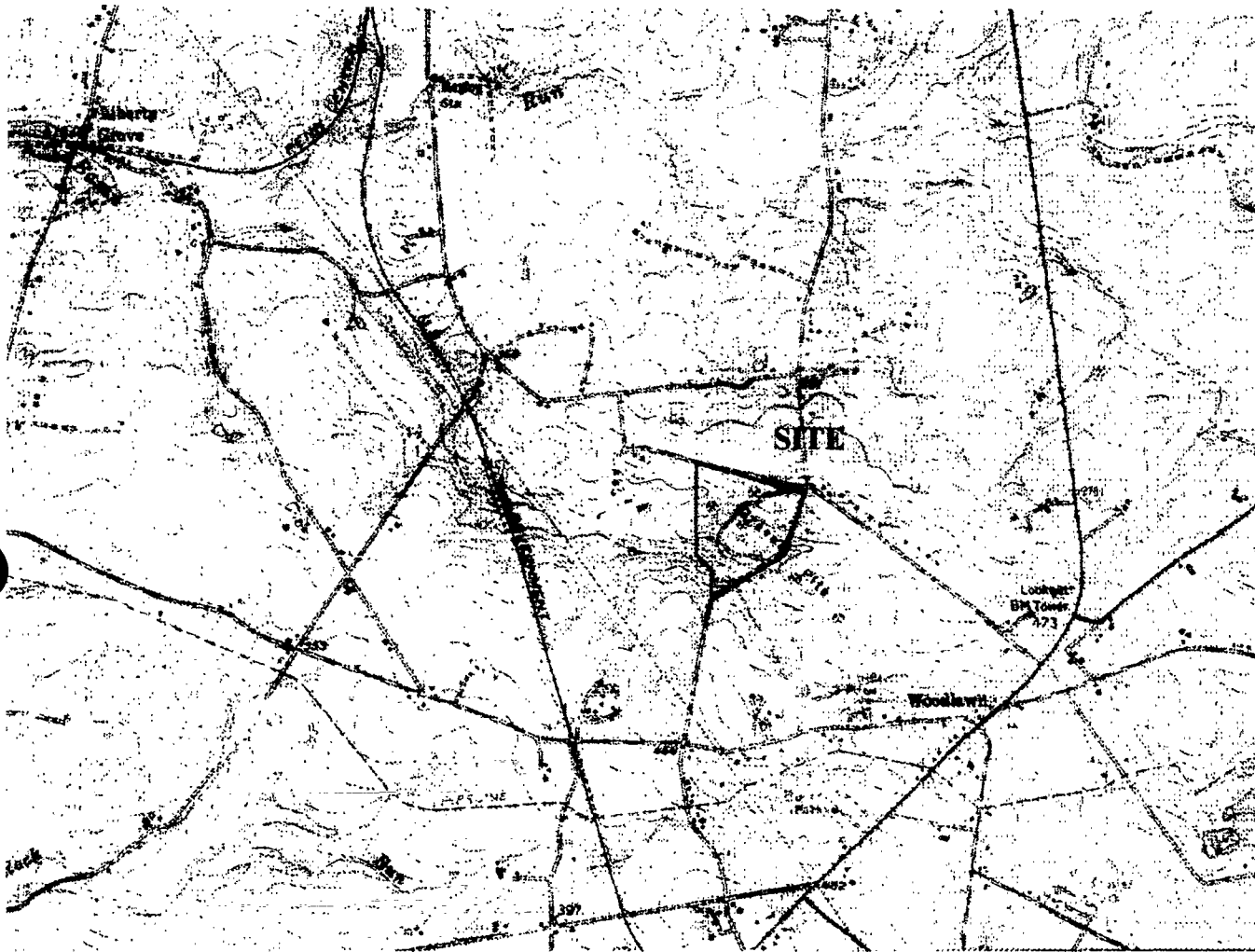
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12. Brady, Nyle C. 1992. The Nature and Properties of Soils, Tenth Edition. MacMillan Publishing Company, New York, New York.
13. United States Environmental Protection Agency 1993. RCRA Groundwater Monitoring: Draft Technical Guidance, EPA/530-R-93-001.
14. Wiedemeir, Todd H., et al., 1996. Draft-Revision No. 1 Technical Protocols for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, Air Force Center for Environmental Excellence, Technology Transfer Division, San Antonio, Texas, November 1996.
15. ARCADIS Geraghty & Miller 1998. Revised Long-Term Groundwater Monitoring Plan, Woodlawn Landfill, Cecil County, Maryland, July 14, 1998.
16. United States Environmental Protection Agency 1992. Methods for Evaluating the Attainment of Cleanup Standards - Volume 2: Groundwater, 1992.
17. United States Environmental Protection Agency 1994. Administrative Order (EPA Docket No. III-95-05-DC), Woodlawn Landfill Superfund Site, November 25, 1994.

Table 5-1
Opinion of Probable Costs for Vegetative Cover System
Bridgestone/Firestone, Inc.
Woodlawn Landfill
Cecil County, Maryland

Item	Quantity	Unit	Unit Cost	Total Cost
GENERAL REQUIREMENTS				
Mobilization/demobilization	1	LS	\$20,000	\$20,000
Test Pit Investigation	1	LS	\$10,000	\$10,000
Closure Report	1	LS	\$15,000	\$15,000
Stabilized Construction Entrance	1	LS	\$6,000	\$6,000
VEGETATIVE COVER CONSTRUCTION				
Clearing and Grubbing of Trees	5	AC	\$7,200	\$36,000
Clearing and Grubbing of Brush, Shrubs, and Saplings	15.5	AC	\$4,800	\$74,400
Erosion Control (erosion mat, silt fence, etc.)	1	LS	\$35,000	\$35,000
Protective Soil Layer (common borrow - 6 inches)	16,600	CY	\$11.30	\$187,600
Seeding	20.5	AC	\$1,300	\$26,700
Topsoil (6 inches)	16,600	CY	\$18.00	\$298,800
PERIMETER SECURITY FENCE				
Chain Link Fence (6 feet high, galvanized steel)	4,920	LF	\$16.40	\$80,688
Corner Posts and Braces	1	LS	\$8,000	\$8,000
Gates (Vehicle and Personnel)	1	LS	\$35,000	\$35,000
TEMPORARY SEDIMENT PONDS				
Sedimentation Structure (inlets, outlets, traps, risers, etc.)	2	each	\$16,000	\$32,000
Diversion Ditches, Berms	2,640	LF	\$9.50	\$25,080
Geotextile Fabric	1,625	SF	\$0.17	\$276
Perimeter Berm (cut fill)	1,800	CY	\$5.75	\$10,350
Demolish Basins/Traps	2	each	\$15,000	\$30,000
			Subtotal	\$930,894
			Engineering and Administration (10%)	\$93,100
			Construction Management (12%)	\$111,700
			Health and Safety (5%)	\$46,500
			Construction Cost Subtotal	\$1,182,194
			Contingency (15%)	\$177,300
			TOTAL CONSTRUCTION COST	\$1,360,000
ANNUAL O&M COSTS (POST-CLOSURE CARE)				
Cover Inspection and Maintenance		LS		\$12,000
Fence Maintenance				\$5,000
Mowing	20.5	AC	\$800	\$16,400
			Subtotal	\$33,400
			Administration (5%)	\$1,700
			Annual O&M Subtotal	\$35,100
			Contingency (15%)	\$5,300
			TOTAL ANNUAL O&M COSTS	\$40,000
TOTAL PRESENT WORTH				\$610,000
5% over 30 years				
TOTAL COST FOR VEGETATIVE COVER SYSTEM				\$1,970,000

Table 5-2
 Opinion of Probable Costs for Single-Barrier Cap System
 Bridgestone/Firestone, Inc.
 Woodlawn Landfill
 Cecil County, Maryland

Item	Quantity	Unit	Unit Cost	Total Cost
GENERAL REQUIREMENTS				
Mobilization/demobilization	1	LS	\$60,000	\$60,000
Closure Report	1	LS	\$20,000	\$20,000
Stabilized Construction Entrance	1	LS	\$6,000	\$6,000
SINGLE-BARRIER CAP CONSTRUCTION				
Clearing and Grubbing	20.5	AC	\$4,800	\$98,400
Erosion Control	1	LS	\$35,000	\$35,000
Subbase Layer (common borrow - 6 inches)	16,540	CY	\$11.30	\$186,902
Flexible Membrane Liner (40-mil thick LLDPE)	895,000	SF	\$0.40	\$358,000
Drainage Layer (geocomposite)	895,000	SF	\$0.50	\$447,500
Protective Soil Layer (common borrow - 18 inches)	49,700	CY	\$11.30	\$561,600
Seeding	20.5	AC	\$1,300	\$26,700
Topsoil (6 inches)	16,600	CY	\$18.00	\$298,800
PERIMETER SECURITY FENCE				
Chain Link Fence (6 feet high, galvanized steel)	4,920	LF	\$16.40	\$80,688
Corner Posts and Braces	1	LS	\$8,000	\$8,000
Gates (Vehicle and Personnel)	1	LS	\$35,000	\$35,000
PASSIVE GAS COLLECTION SYSTEM				
Trenching	70	CY	\$4.53	\$317
Transmission Piping (4-inch dia., perforated polyethylene)	3,630	LF	\$4.55	\$16,517
Passive Gas Vents w/Rotary Turbine Ventilators	12	each	\$1,000	\$12,000
Valves and Fittings	1	LS	\$2,000	\$2,000
TEMPORARY SEDIMENT PONDS				
Sedimentation Structure (inlets, outlets, traps, risers, etc.)	2	each	\$16,000	\$32,000
Diversion Ditches, Berms	2,640	LF	\$9.50	\$25,080
Geotextile Fabric	1,625	SF	\$0.17	\$276
Perimeter Berm (cut fill)	1,800	CY	\$5.75	\$10,350
Demolish Basins/Traps	2	each	\$15,000	\$30,000
			Subtotal	\$2,351,130
			Engineering and Administration (10%)	\$235,100
			Construction Management (12%)	\$282,100
			Health and Safety (5%)	\$117,600
			Construction Cost Subtotal	\$2,985,930
			Contingency (15%)	\$447,900
			TOTAL CONSTRUCTION COST	\$3,430,000
ANNUAL O&M COSTS (POST-CLOSURE CARE)				
Cap Inspection and Maintenance				\$16,000
Mowing	20.5	AC	\$800	\$16,400
Fence Maintenance				\$5,000
			Subtotal	\$37,400
			Administration (5%)	\$1,900
			Annual O&M Subtotal	\$39,300
			Contingency (15%)	\$5,900
			TOTAL ANNUAL O&M COSTS	\$45,000
TOTAL PRESENT WORTH				\$690,000
5%, over 30 years				
TOTAL COST FOR SINGLE-BARRIER CAP SYSTEM				\$4,120,000

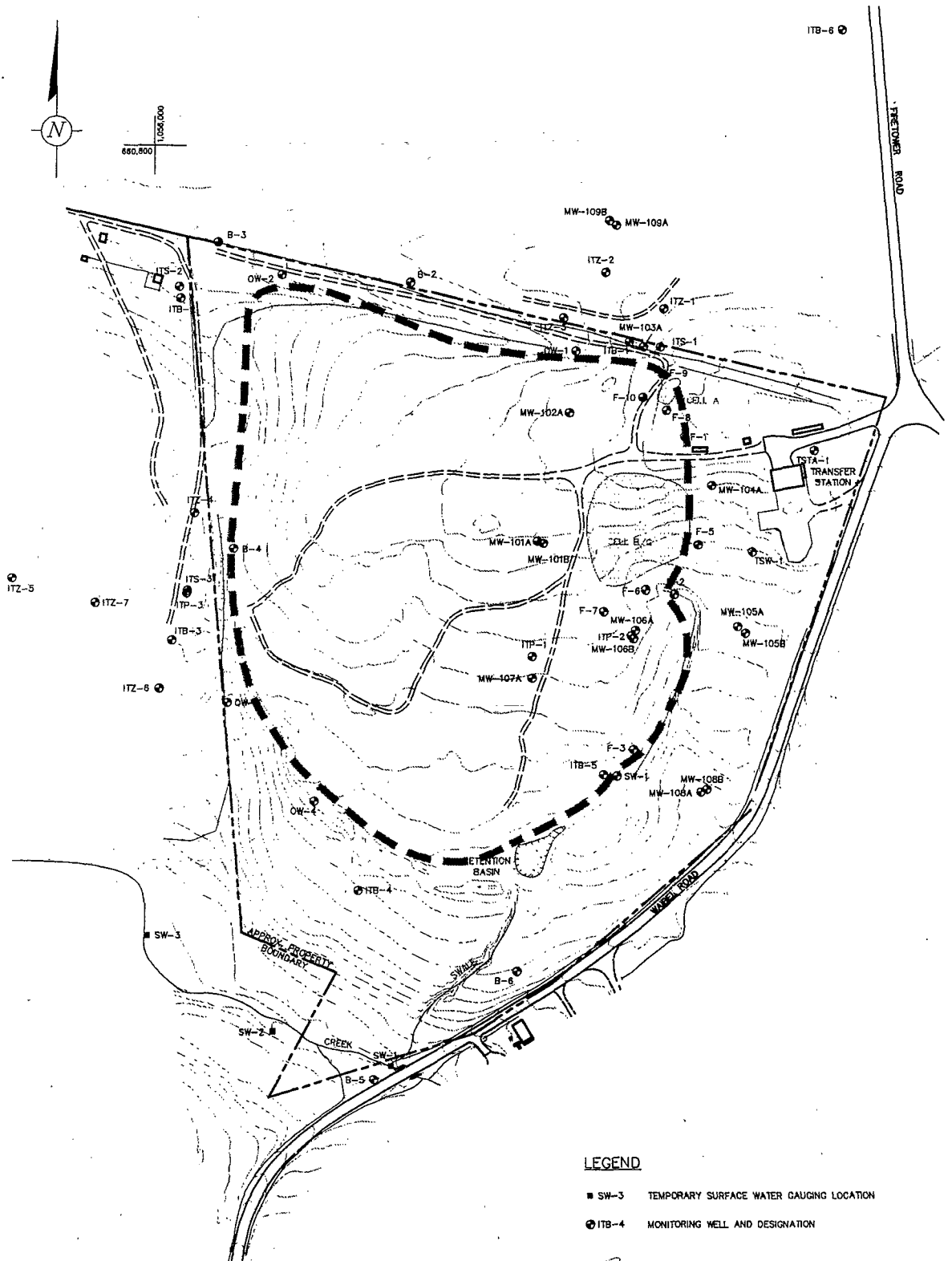


SITE LOCATION MAP

WOODLAWN LANDFILL
 CECIL COUNTY, MARYLAND
 BR312395

FIGURE

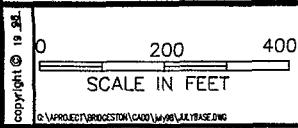
1-1



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ⊙ ITB-4 MONITORING WELL AND DESIGNATION
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- APPROXIMATE LANDFILL BOUNDARY

AR 312396



ARCADIS GERAGHTY & MILLER



DRAWN M. WASKLEWSKI	DATE 7/20/98	PROJECT MANAGER T. STACK	DEPARTMENT MANAGER D. SOUSA
SITE MAP WOODLAWN LANDFILL CECIL COUNTY, MARYLAND		LEAD DESIGN PROF. S. SUTHERSEN	CHECKED J. BURDICK
		PROJECT NUMBER NP000344.0002	DRAWING NUMBER 1-2

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APPROVED: STP

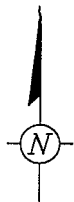
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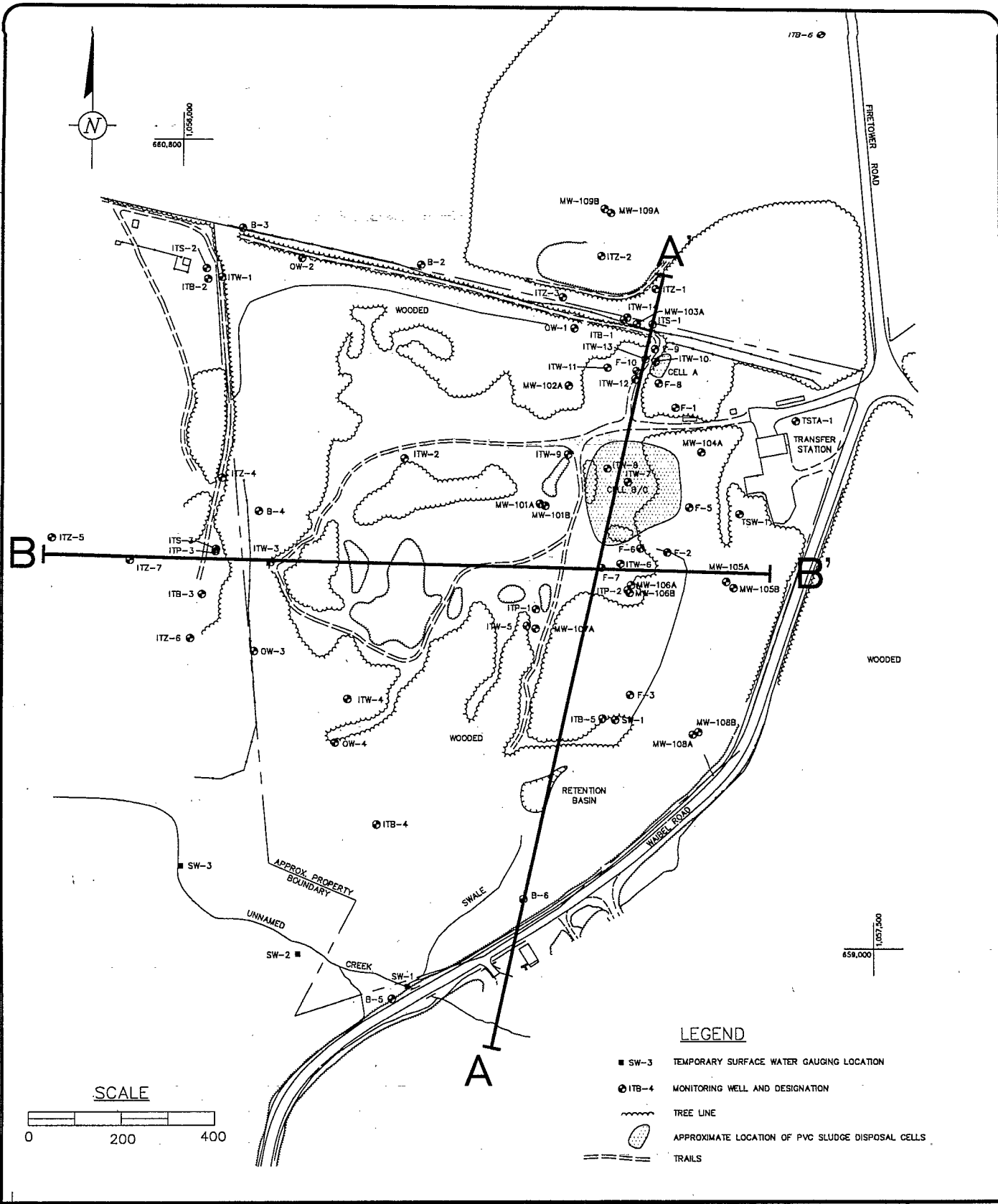
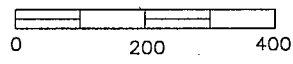
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PRJCT NO.: NP0344.001

DWG DATE: 31 JAN 97



SCALE



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ⊙ ITB-4 MONITORING WELL AND DESIGNATION
- ~~~~~ TREE LINE
- ⬭ APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS



ARCADIS
GERAGHTY & MILLER

Site Map with Geologic Cross Sections.

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

1-3

AR312397

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APPROVED: JH

CHECKED: JMB

DRAWING: NSXSEC

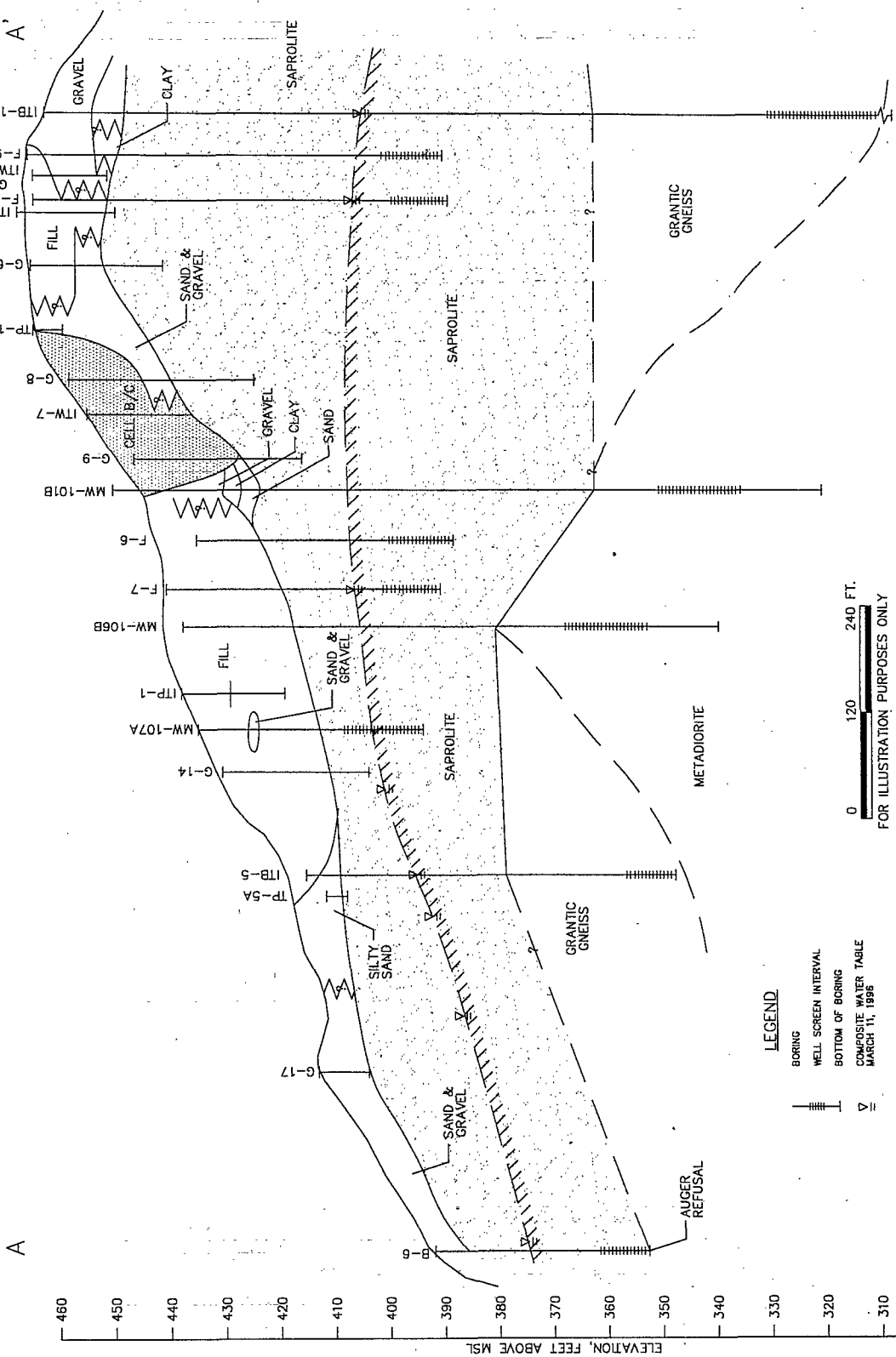
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PRCT NO.: NP0344.001

DWG DATE: DWGDATE

NORTH

SOUTH



FIGURE

1-4

**Generalized North/South
Geologic Cross Section.**

WOODLAWN LANDFILL
Cecil County, Maryland



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DWG DATE: 31JAN97 | PR-JCT NO.: NP0344.001 | FILE NO.: BRDGSSTN | DRAWING: EWXSEC | CHECKED: JMB | APPROVED: JLH | DRAFTER: JSG

WEST
B

EAST
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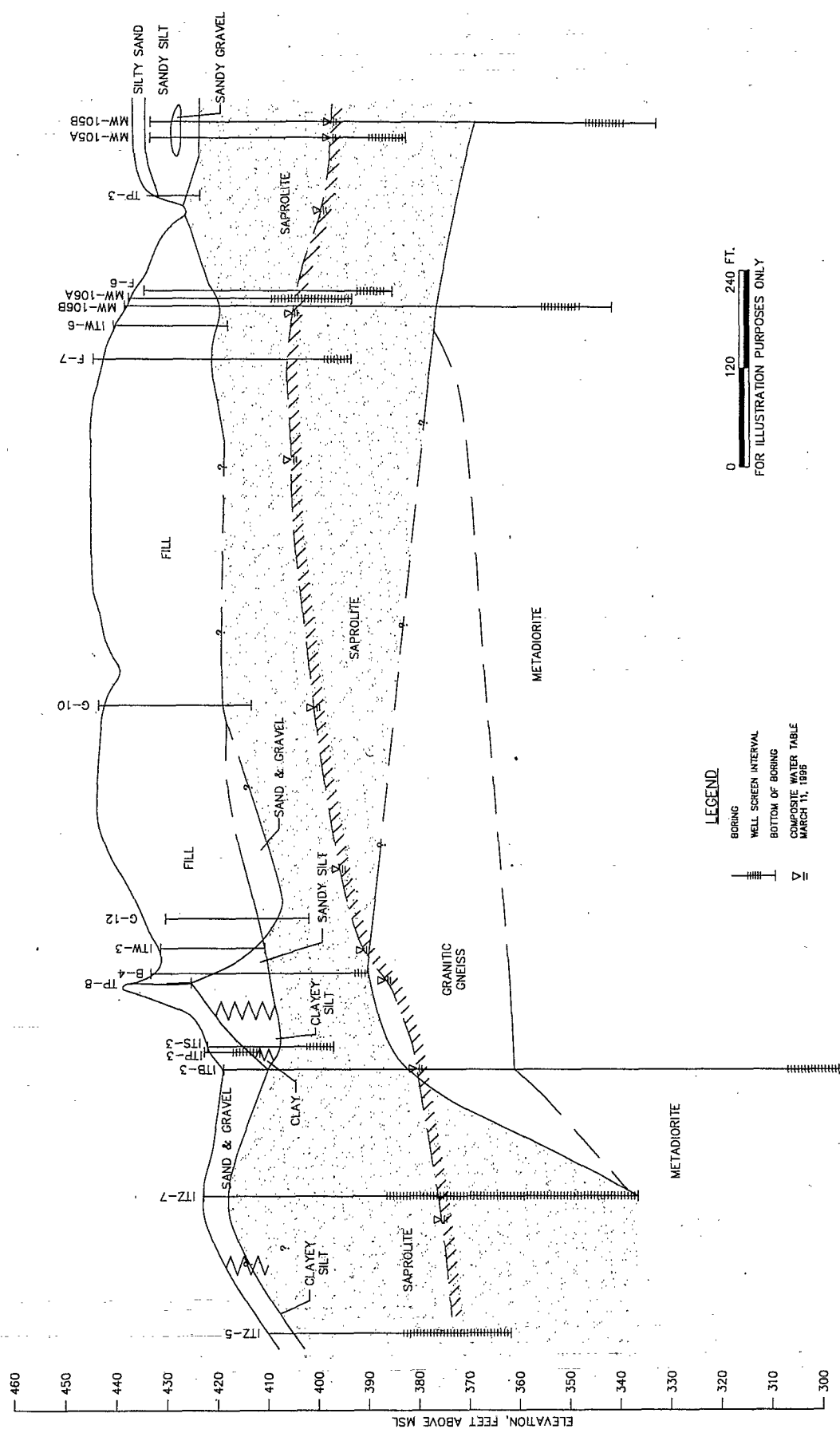


FIGURE
1-5

**Generalized East/West
Geologic Cross Section.**

WOODLAWN LANDFILL
Cecil County, Maryland

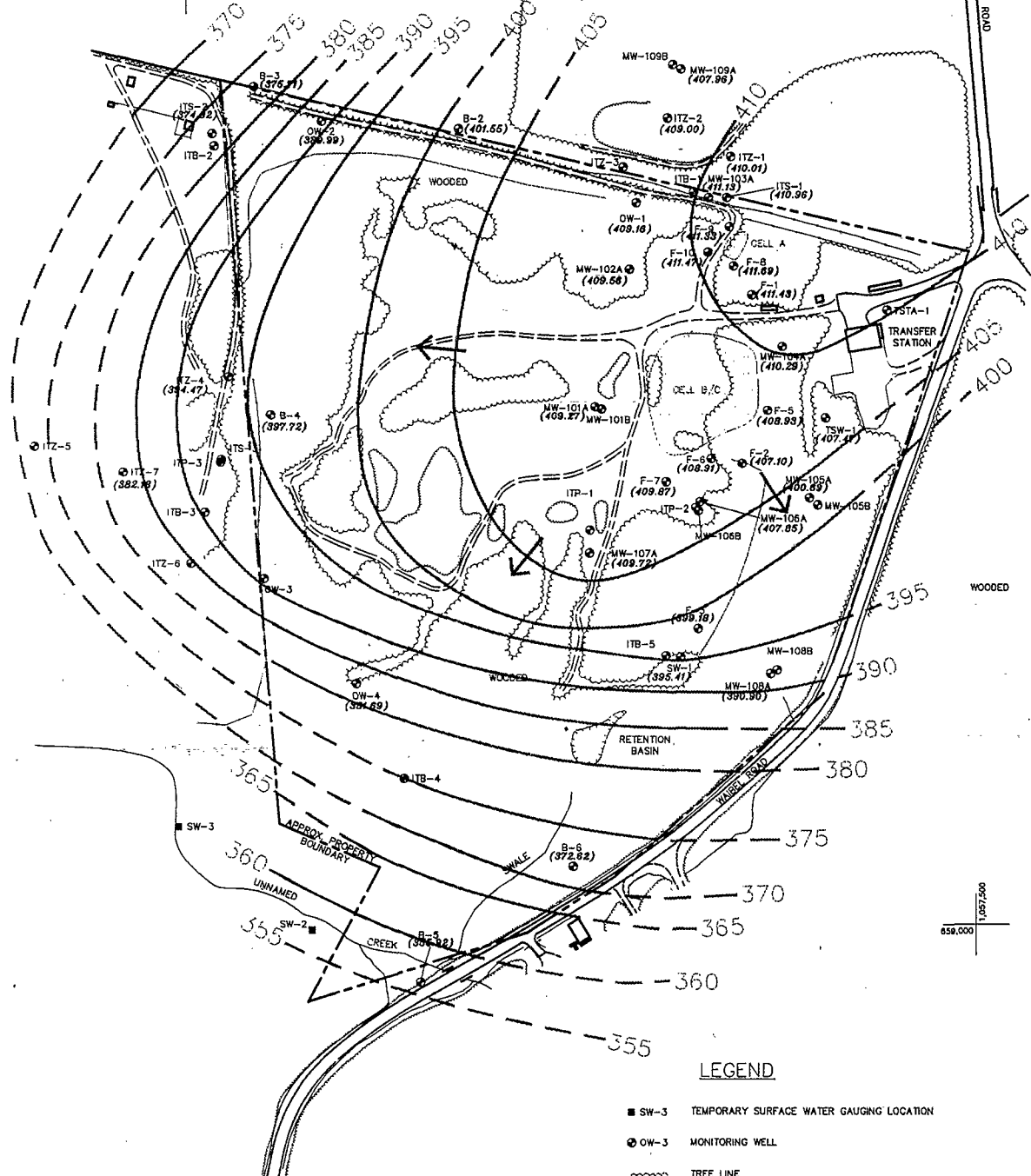


AR312399



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1,056,000

ITB-5
(386.78)

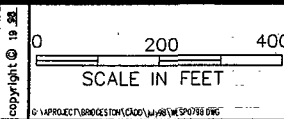


659,000
1,057,500

LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- OW-3 MONITORING WELL
- ~~~~~ TREE LINE
- == TRAILS
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED) AND DIRECTION OF GROUNDWATER FLOW
- (374.92) GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (MSL)

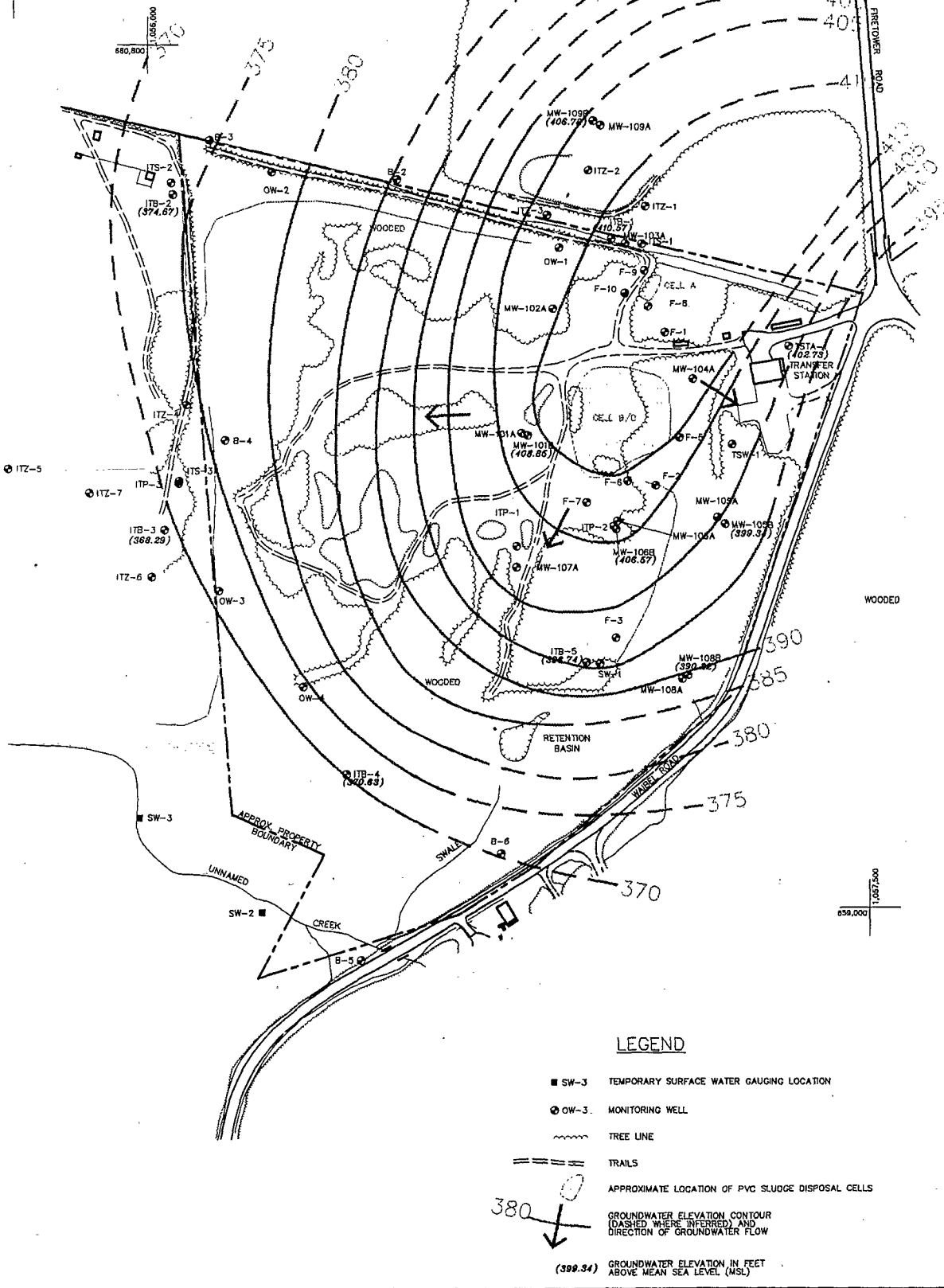
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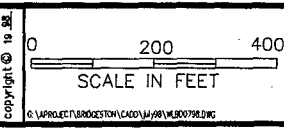


DRAWN M. WASLEWSKI	DATE 7/20/00	PROJECT MANAGER T. STACK	DEPARTMENT MANAGER D. SOUSA
GROUNDWATER ELEVATIONS SAPROLITE WELLS, JULY 1998		LEAD DESIGN PROF. S. SUTHERSEN	CHECKED J. BURDICK
WOODLAWN LANDFILL CECIL COUNTY, MARYLAND		PROJECT NUMBER NP000344.0002	DRAWING NUMBER 1-6A



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- OW-3 MONITORING WELL
- ~~~~~ TREE LINE
- TRAILS
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED) AND DIRECTION OF GROUNDWATER FLOW
- (399.34) GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (MSL)



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DRAWN M. WASLEWSKI	DATE 7/20/98	PROJECT MANAGER T. STACK	DEPARTMENT MANAGER D. SOUSA
GROUNDWATER ELEVATIONS BEDROCK WELLS, JULY 1998		LEAD DESIGN PROF. S. SUMMERS	CHECKED J. BURENCK
WOODLAWN LANDFILL CECIL COUNTY, MARYLAND		PROJECT NUMBER NP000344.0002	DRAWING NUMBER 1-6B

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APPROVED: STP

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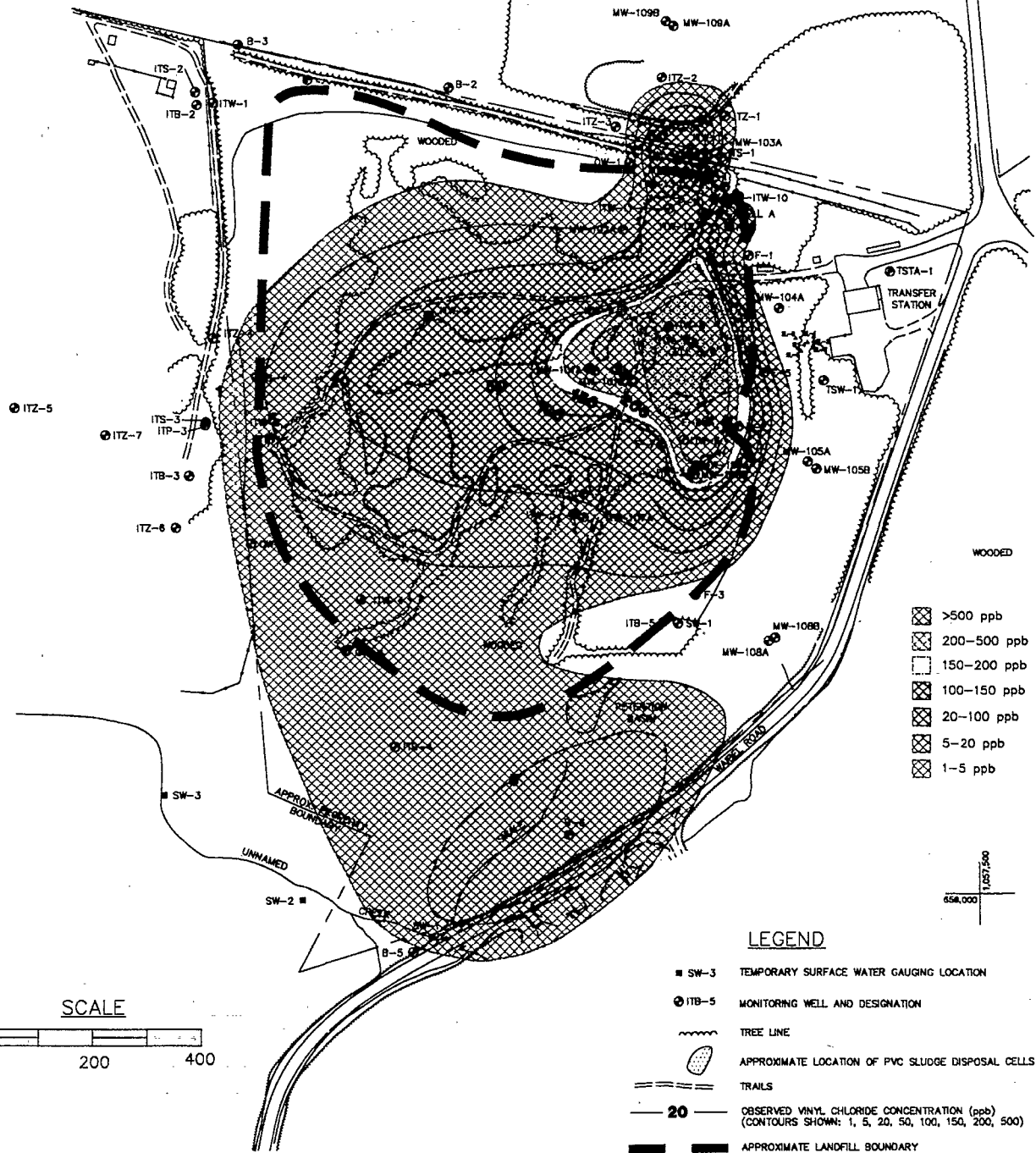
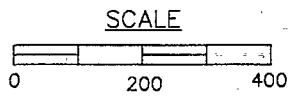
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PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



- >500 ppb
- 200-500 ppb
- 150-200 ppb
- 100-150 ppb
- 20-100 ppb
- 5-20 ppb
- 1-5 ppb

LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ITB-5 MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 20 OBSERVED VINYL CHLORIDE CONCENTRATION (ppb) (CONTOURS SHOWN: 1, 5, 20, 50, 100, 150, 200, 500)
- APPROXIMATE LANDFILL BOUNDARY



Observed Vinyl Chloride Concentrations in Groundwater November, 1987

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

1-7

AR312402

DRAFTER: P.G.J.

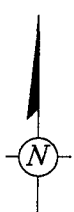
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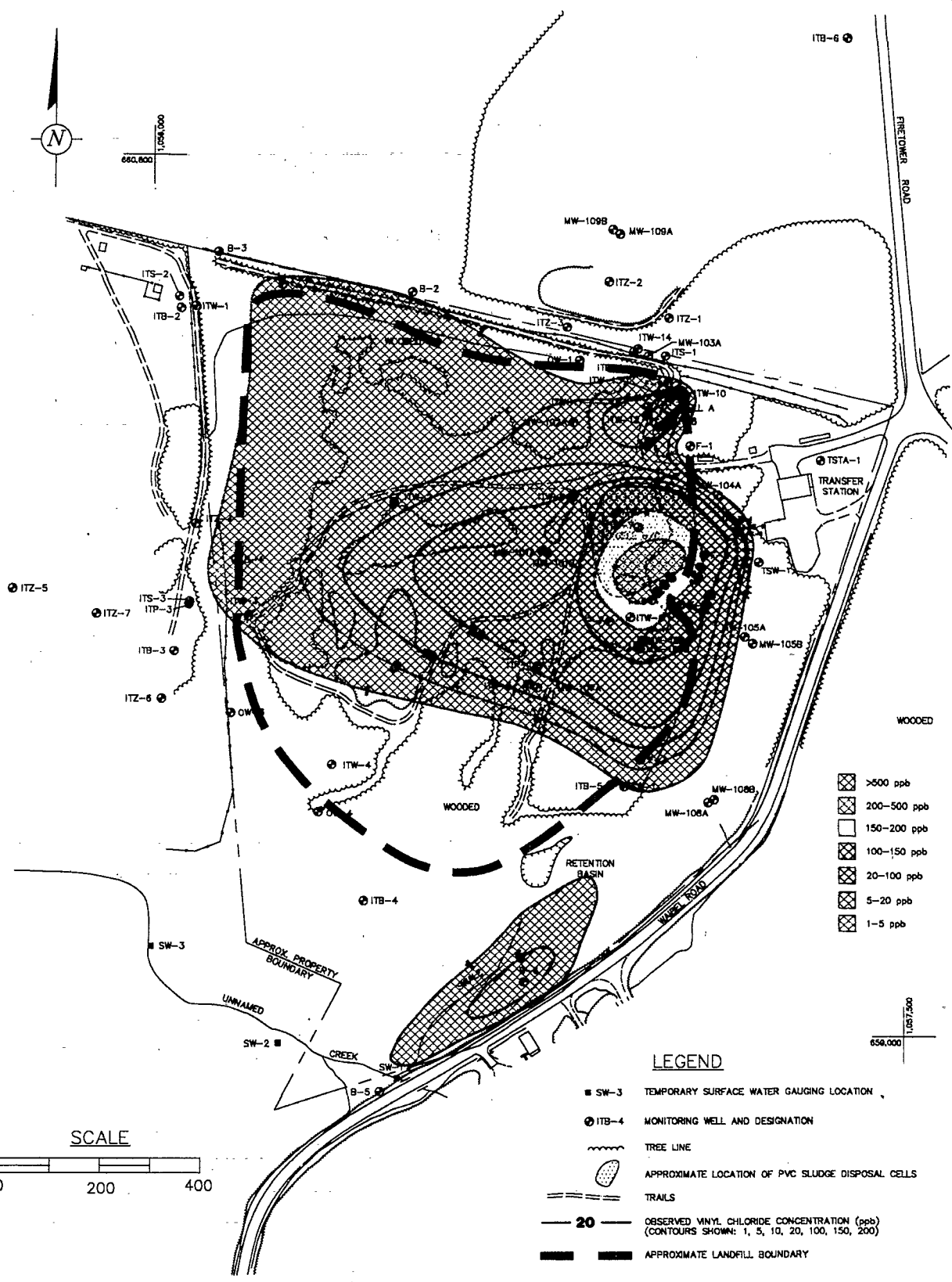
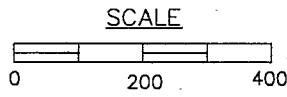
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DWG NO.: 06AUG98



660,800
1,050,000



- >500 ppb
- 200-500 ppb
- 150-200 ppb
- 100-150 ppb
- 20-100 ppb
- 5-20 ppb
- 1-5 ppb

LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ITB-4 MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 20 OBSERVED VINYL CHLORIDE CONCENTRATION (ppb) (CONTOURS SHOWN: 1, 5, 10, 20, 100, 150, 200)
- APPROXIMATE LANDFILL BOUNDARY



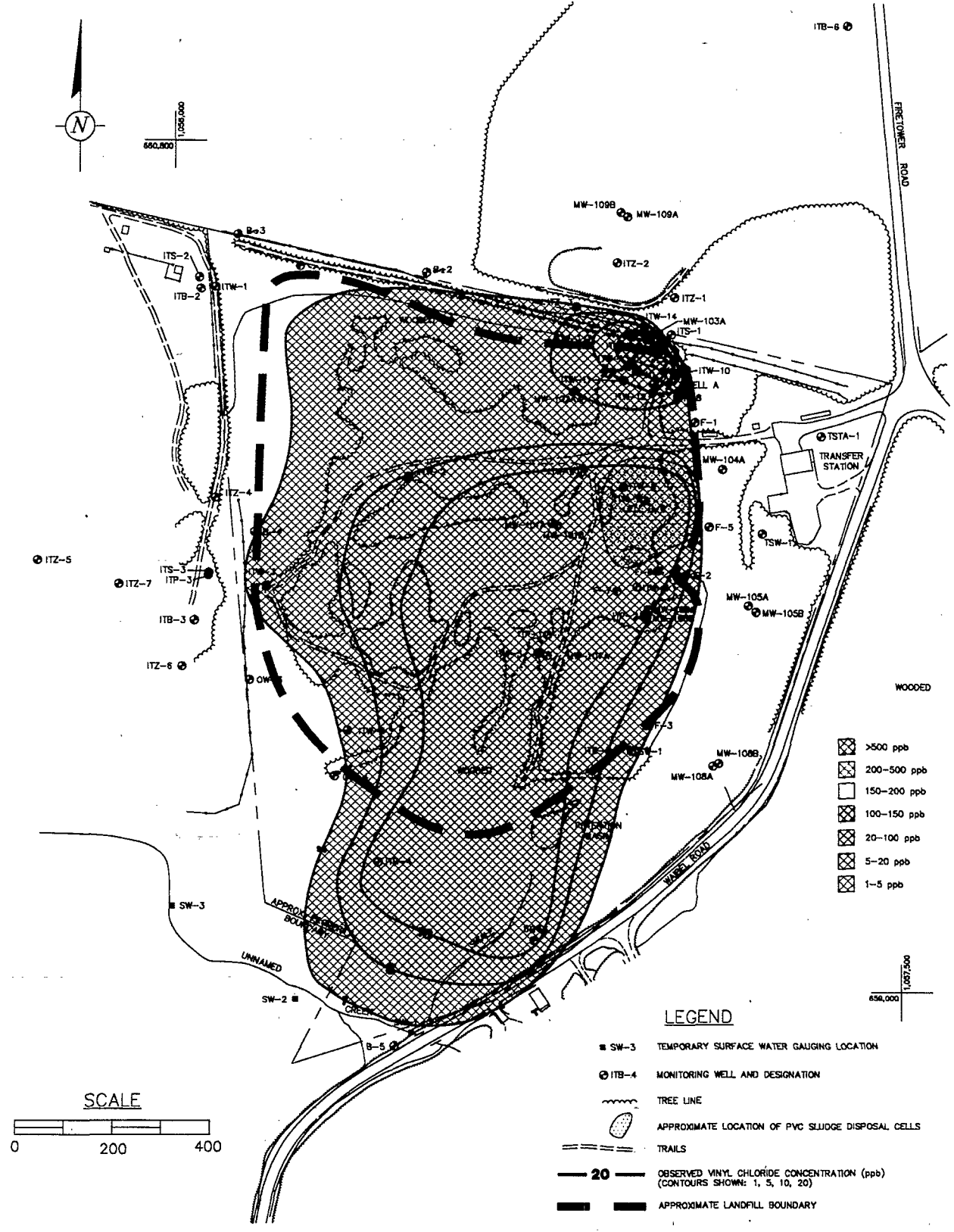
**Observed Vinyl Chloride
Concentrations in Groundwater, Sapolite
November, 1990**

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
1-8

AR312403

DWG DATE: 06AUG98 | PRJCT NO.: NP0344.001 | FILE NO.: BRDGSN | DRAWING: VC_BED90.DWG | CHECKED: STP | APPROVED: STP | DRAFTER: JGJ



Observed Vinyl Chloride Concentrations in Groundwater, Bedrock November, 1990
 WOODLAWN LANDFILL
 Cecil County, Maryland

FIGURE
1-9

AR312404

DRAFTER: JGJ

APPROVED: STP

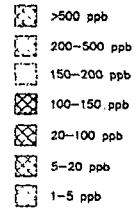
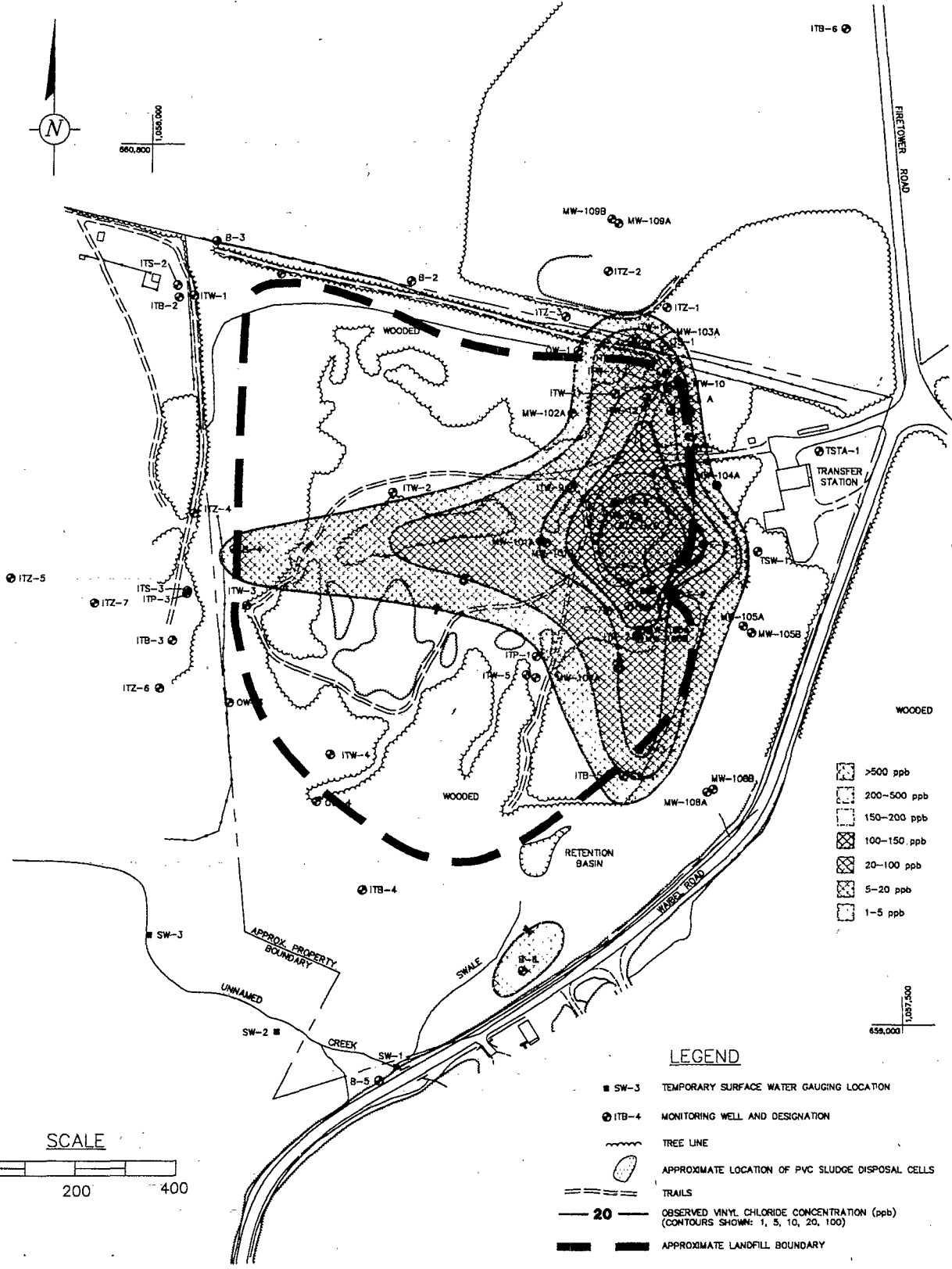
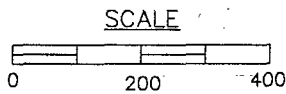
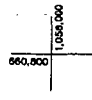
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DRAWING: VC_SAP.DWG

FILE NO.: BRDCSTN

PRJCT NO.: NP0344-001

DWG DATE: 06AUG98



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ⊙ ITB-4 MONITORING WELL AND DESIGNATION
- ~ TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 20 — OBSERVED VINYL CHLORIDE CONCENTRATION (ppb)
(CONTOURS SHOWN: 1, 5, 10, 20, 100)
- APPROXIMATE LANDFILL BOUNDARY



ARCADIS
GERAGHTY & MILLER

Observed Vinyl Chloride Concentrations in Groundwater, Saprolite March, 1996

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

1-10

AR312405

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

DRAWING: VC_BED.DWG

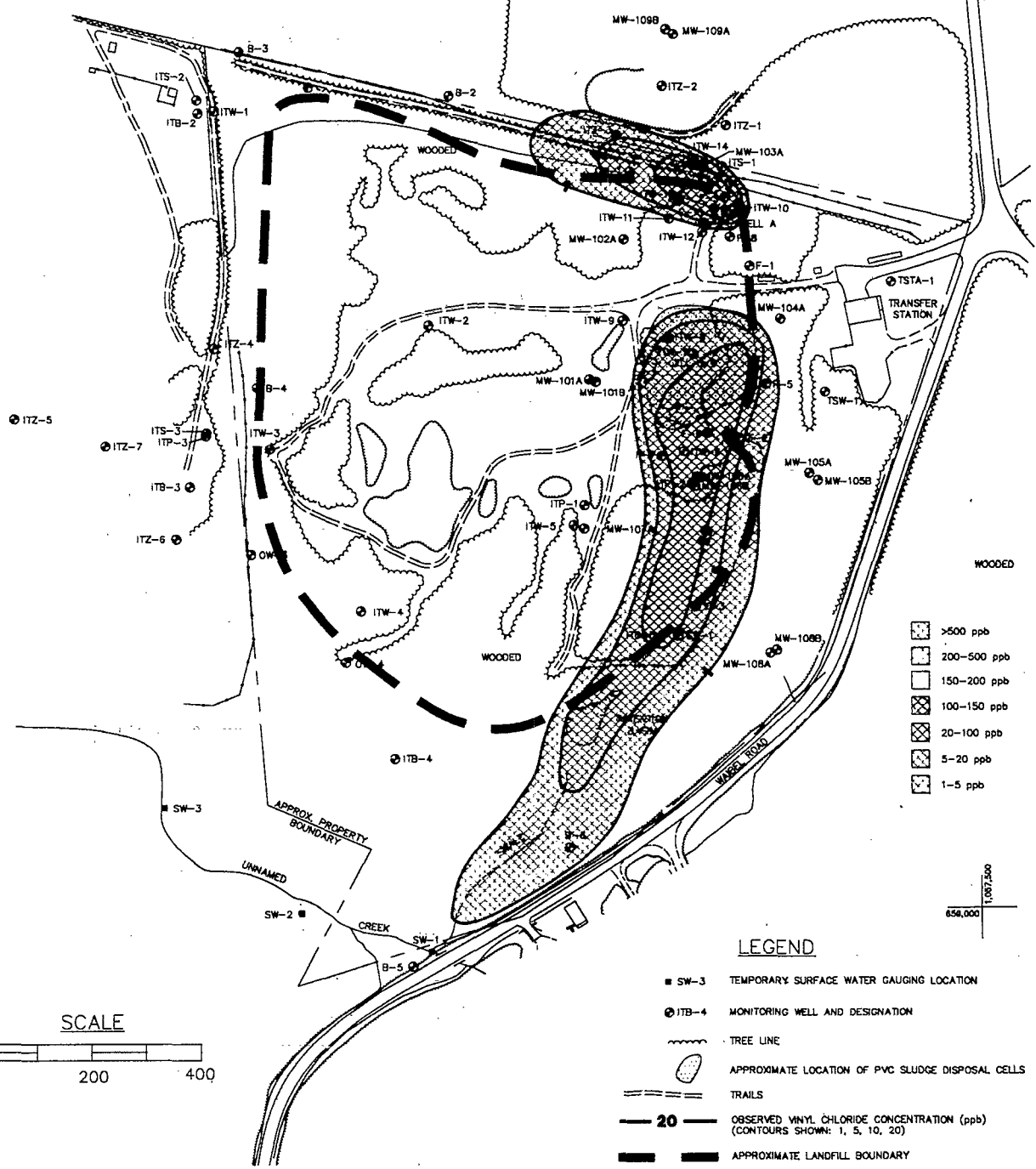
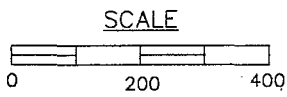
FILE NO.: BRDGSN

PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



660,800
1,086,000



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ITB-4 MONITORING WELL AND DESIGNATION
- ~ TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 20 — OBSERVED VINYL CHLORIDE CONCENTRATION (ppb)
(CONTOURS SHOWN: 1, 5, 10, 20)
- APPROXIMATE LANDFILL BOUNDARY

656,000
1,087,500



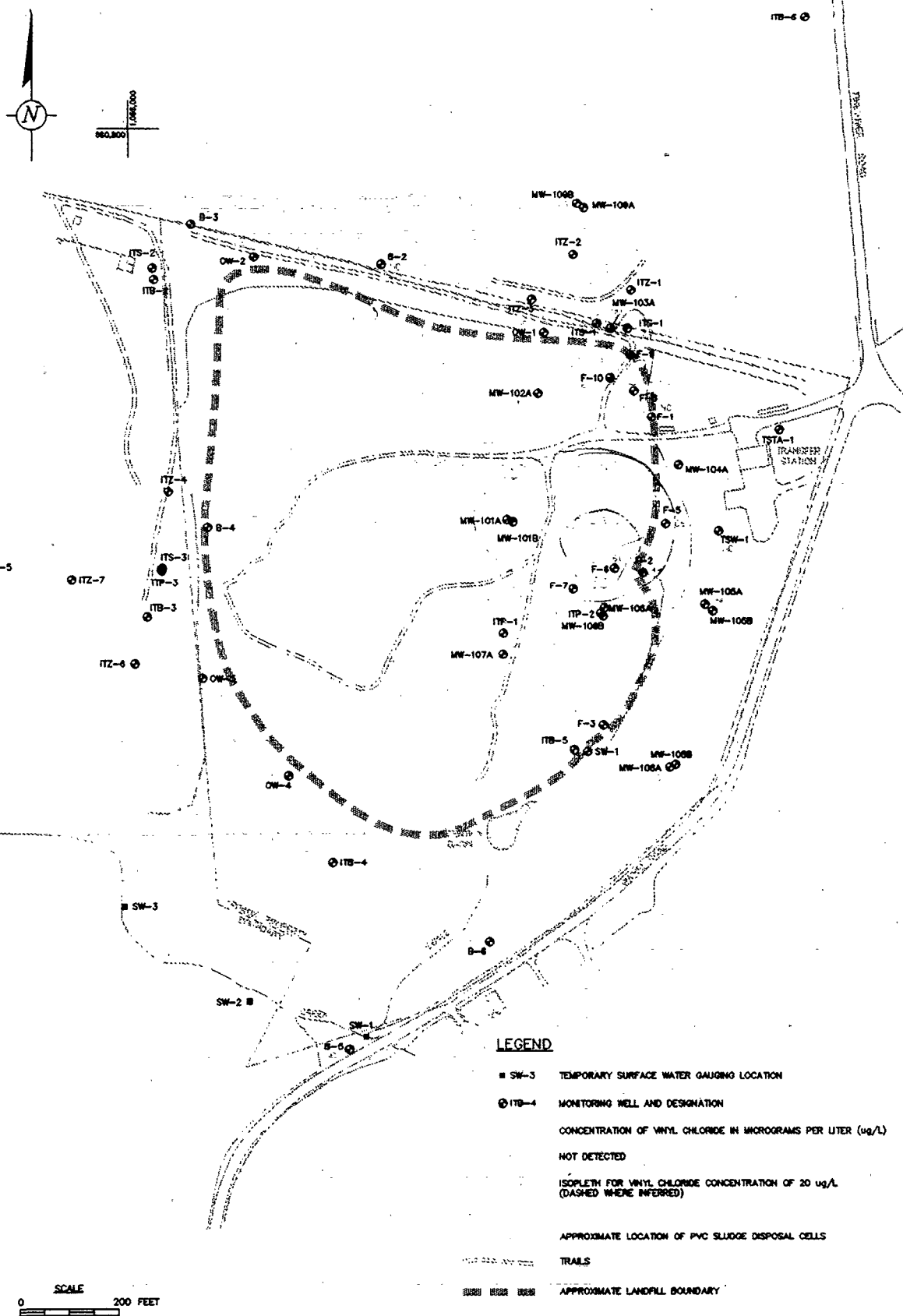
Observed Vinyl Chloride Concentrations in Groundwater, Bedrock March, 1996

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
1-11

AR312406

DWG DATE: 05/97 | PROJECT NO.: NP0344.001 | FILE NO.: BRDGSN | DRAWING: VCS | DWG | CHECKED: STP | APPROVED: STP | DRAFTSMAN: M. WASILEWSKI



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ⊙ ITB-4 MONITORING WELL AND DESIGNATION
- CONCENTRATION OF VINYL CHLORIDE IN MICROGRAMS PER LITER (ug/L)
- NOT DETECTED
- ISOPLETH FOR VINYL CHLORIDE CONCENTRATION OF 20 ug/L (DASHED WHERE INFERRED)
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- APPROXIMATE LANDFILL BOUNDARY

CONTOUR INTERVAL: 1, 20, & 50 ug/L



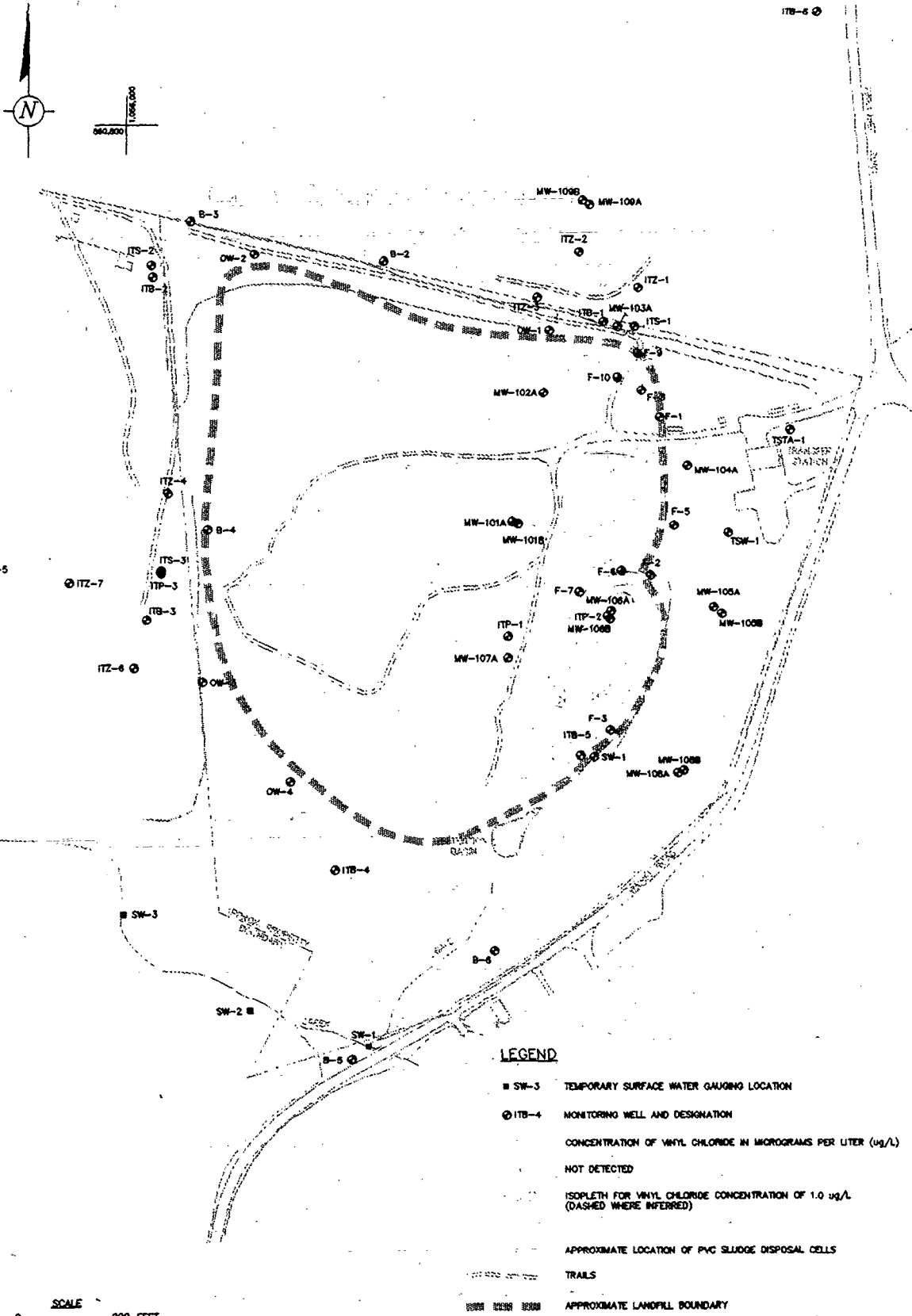
**OBSERVED VINYL CHLORIDE CONCENTRATIONS
IN GROUNDWATER, SAPROLITE**

MAY, 1997

WOODLAWN LANDFILL
CECIL COUNTY, MARYLAND AR3.12407

FIGURE

1-12



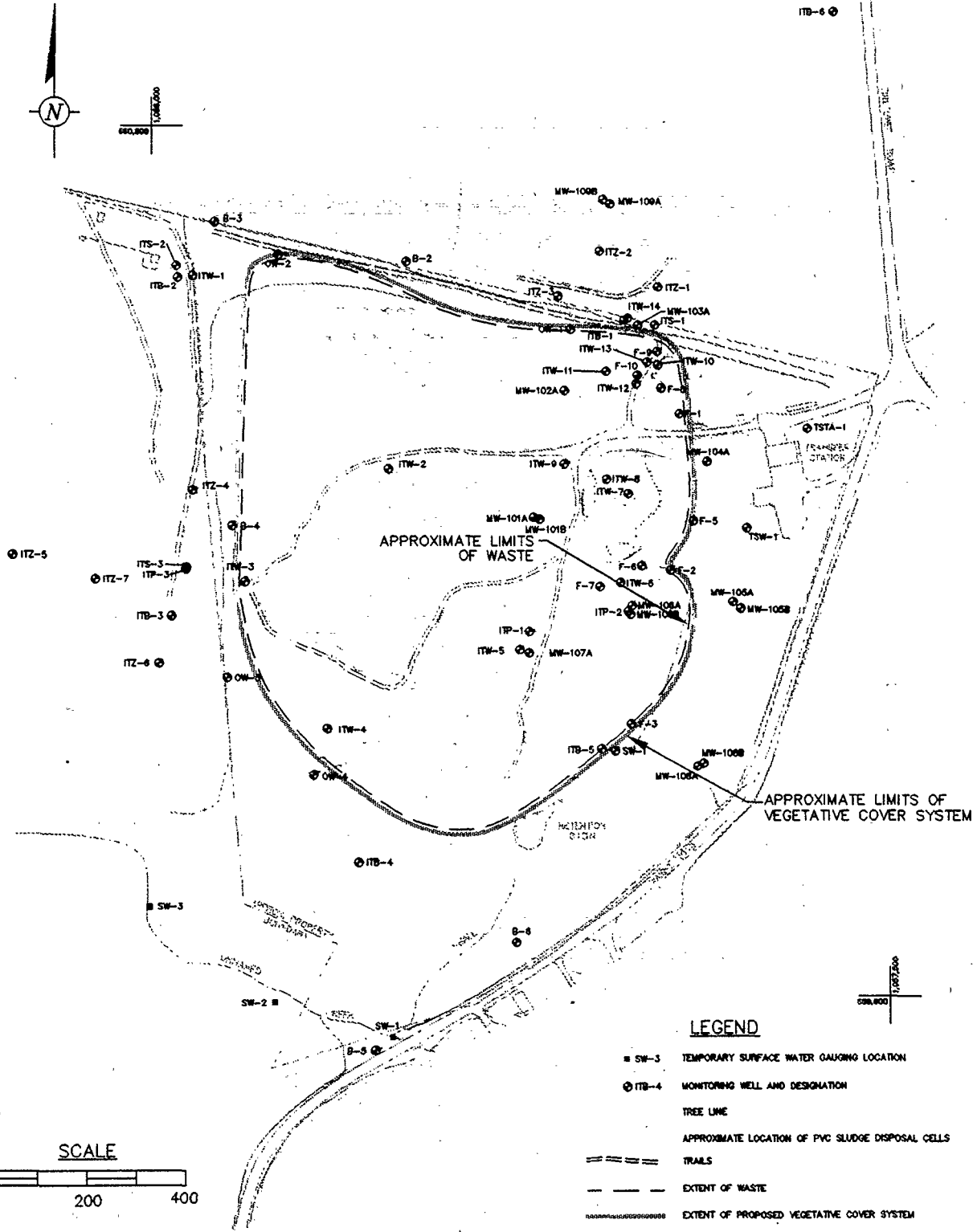
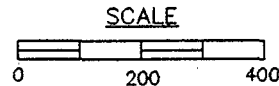
**OBSERVED VINYL CHLORIDE CONCENTRATIONS
IN GROUNDWATER, BEDROCK**

MAY, 1997

WOODLAWN LANDFILL
CECIL COUNTY, MARYLAND R312408

FIGURE

1-13



APPROXIMATE LIMITS OF VEGETATIVE COVER SYSTEM

WOODLAWN LANDFILL
CECIL COUNTY, MARYLAND AR312409

FIGURE
3-1

DRAFTER: MASILEWSKI

APPROVED: J.L.H.

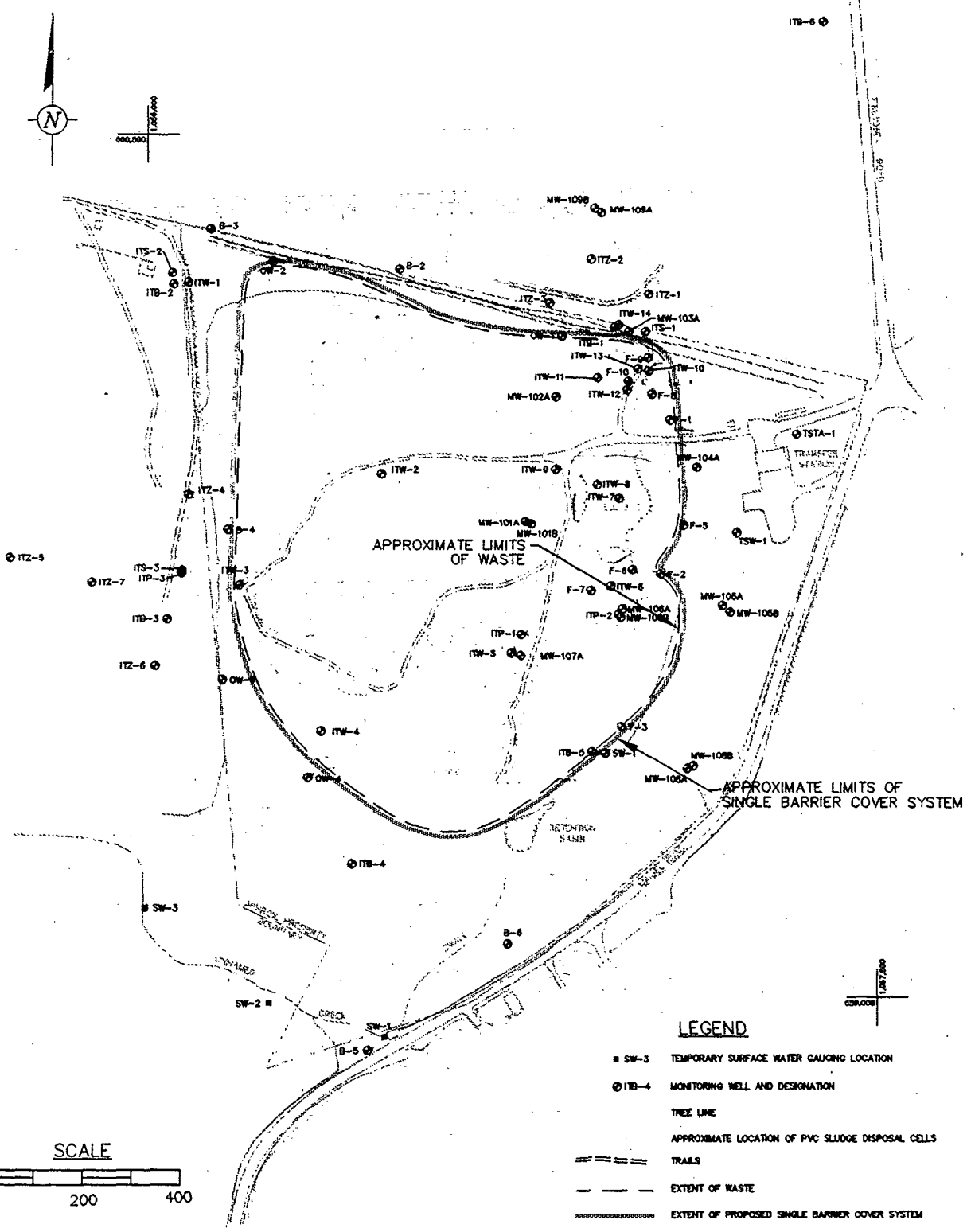
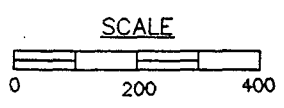
CHECKED: J.M.B.

DRAWING: LSB

FILE NO.: BRDGSN

PRJCT NO.: NP0344.001

DWG DA: AN97



LEGEND

- SW-3 TEMPORARY SURFACE WATER GAUGING LOCATION
- ITB-4 MONITORING WELL AND DESIGNATION
- TREE LINE
- - - APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- - - EXTENT OF WASTE
- EXTENT OF PROPOSED SINGLE BARRIER COVER SYSTEM



APPROXIMATE LIMITS OF SINGLE BARRIER COVER SYSTEM

WOODLAWN LANDFILL AR312410
CECIL COUNTY, MARYLAND

FIGURE
3-2

DRAFTER: JGJ

APPROVED: STP

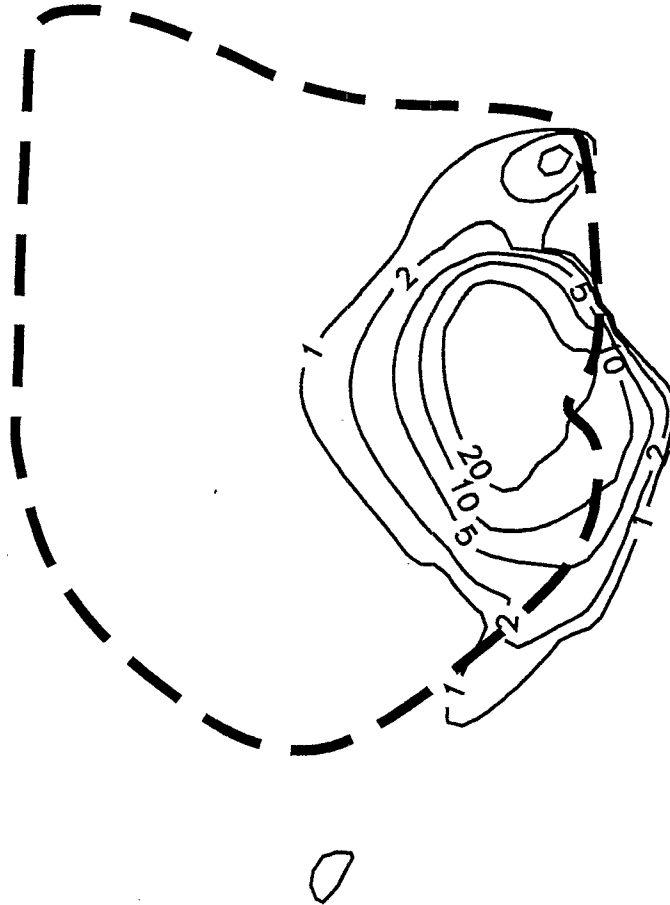
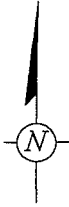
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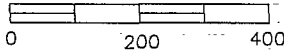
BRDGSTN

PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



SCALE



LEGEND

TEMPORARY SURFACE WATER, GAUGING LOCATION

MONITORING WELL AND DESIGNATION

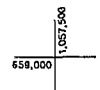
TREE LINE

APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS

TRAILS

1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100

— — — — — APPROXIMATE LANDFILL BOUNDARY



ARCADIS
GERAGHTY & MILLER

**Predicted Vinyl Chloride Concentrations
in Saprolite, Year 2001
Vegetative Cover Alternative**

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

4-1

AR312411

DRAFTER: JGU

APPROVED: STP

CHECKED: STP

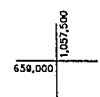
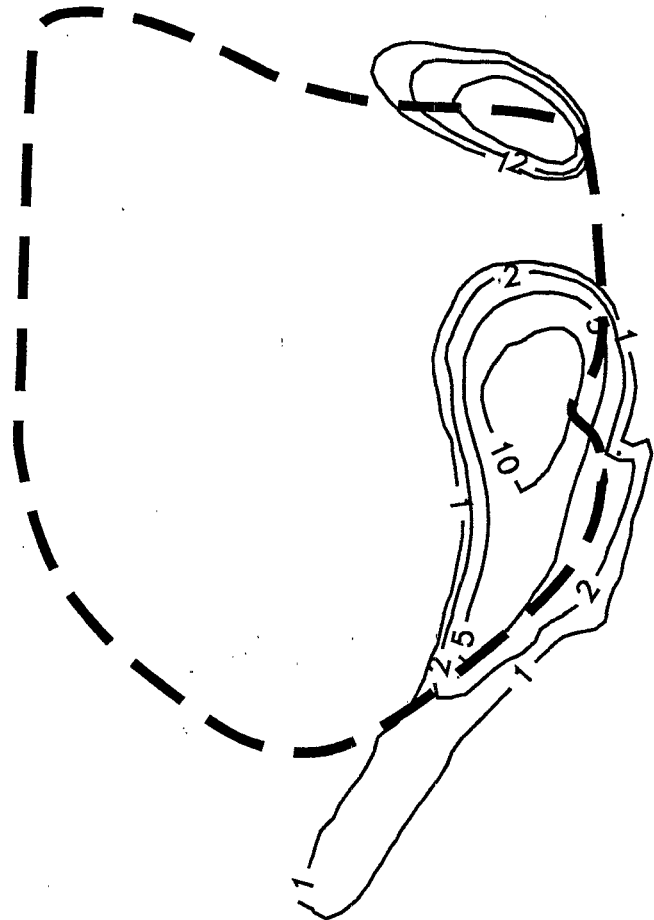
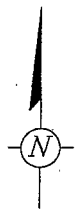
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BRDGSTN

FILE NO.: BRDGSTN

NP0344.001

DWG DATE: 06AUG98



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 — SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100
- APPROXIMATE LANDFILL BOUNDARY



**Predicted Vinyl Chloride Concentrations
in Bedrock, Year 2001
Vegetative Cover Alternative**

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
4-2

AR312412

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

DRAWING: NA10L1.DWG

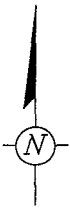
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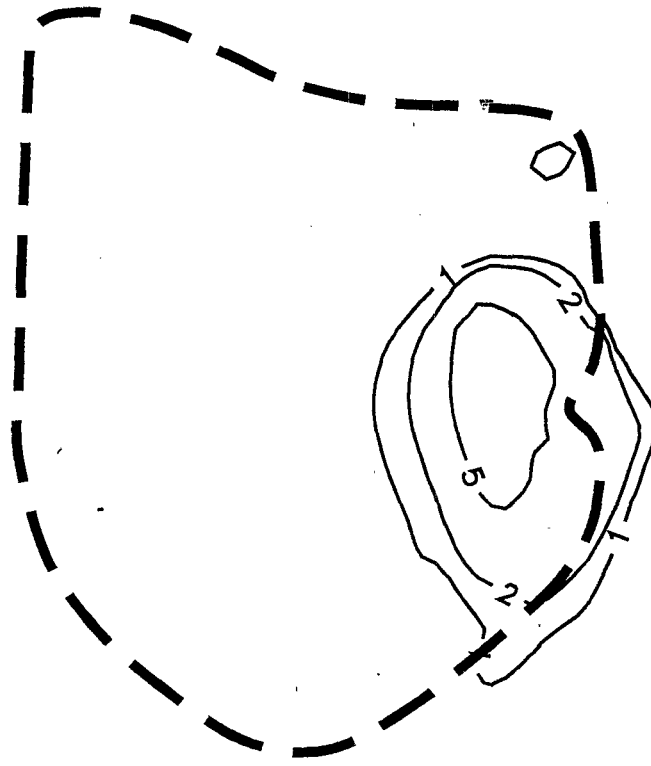
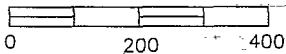
NP0344.001

PRJCT NO.:

06AUG98



SCALE



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100
- APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Saprolite, Year 2006
Vegetative Cover Alternative
WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
4-3

AR312413

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

DRAWING: NA10L2.DWG

BRDGSTN

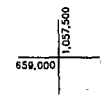
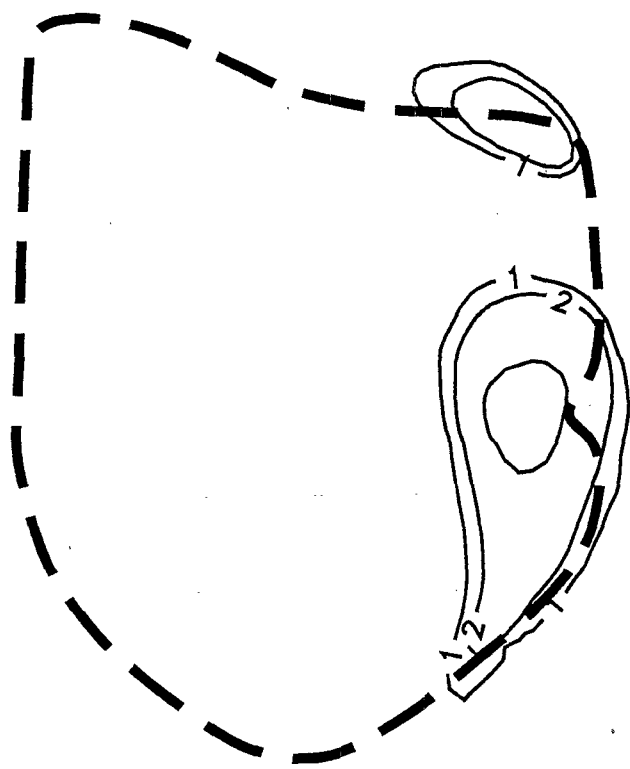
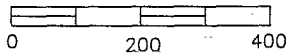
FILE NO.:

PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



SCALE



LEGEND

TEMPORARY SURFACE WATER GAUGING LOCATION

MONITORING WELL AND DESIGNATION

TREE LINE

APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS

TRAILS

1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100

——— APPROXIMATE LANDFILL BOUNDARY



ARCADIS
GERAGHTY & MILLER

**Predicted Vinyl Chloride Concentrations
in Bedrock, Year 2006
Vegetative Cover Alternative**

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

4-4

AR312414

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

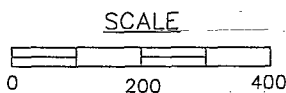
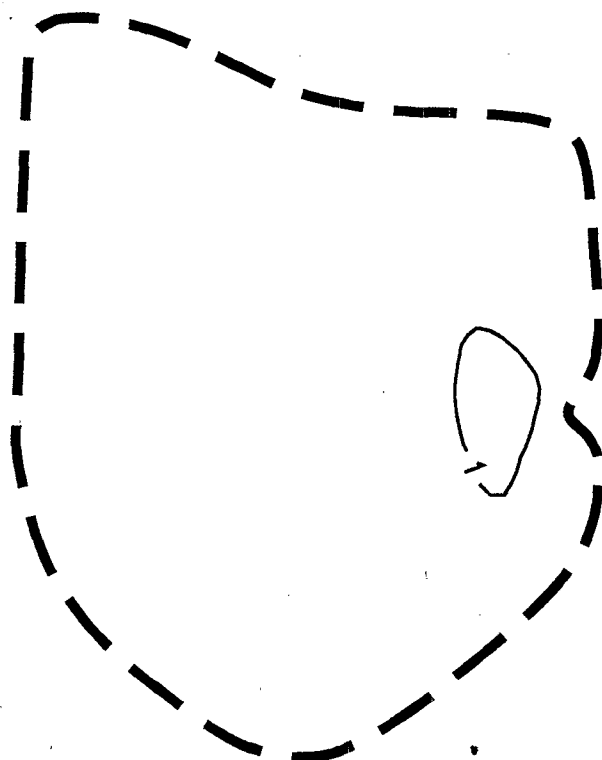
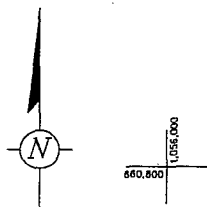
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BRDGSTN

FILE NO.:

PRJCT NO.: NPO344.001

DWG DATE: 06AUG98



LEGEND

TEMPORARY SURFACE WATER GAUGING LOCATION

MONITORING WELL AND DESIGNATION

TREE LINE

APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS

TRAILS

1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100

— — — — — APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Saproliite, Year 2011
Vegetative Cover Alternative

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

4-5

AR312415

DRAFTER: JCU

APPROVED: STP

CHECKED: STP

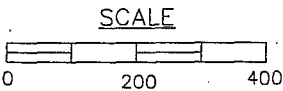
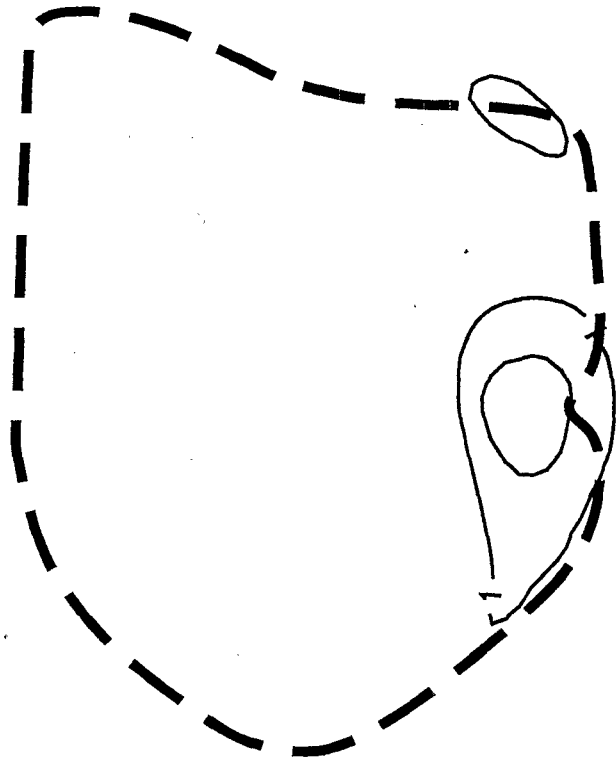
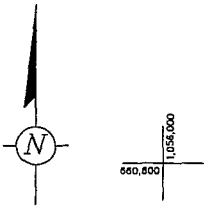
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FILE NO.:

PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100
- APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Bedrock, Year 2011
Vegetative Cover Alternative
WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
4-6

AR312416

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

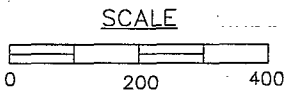
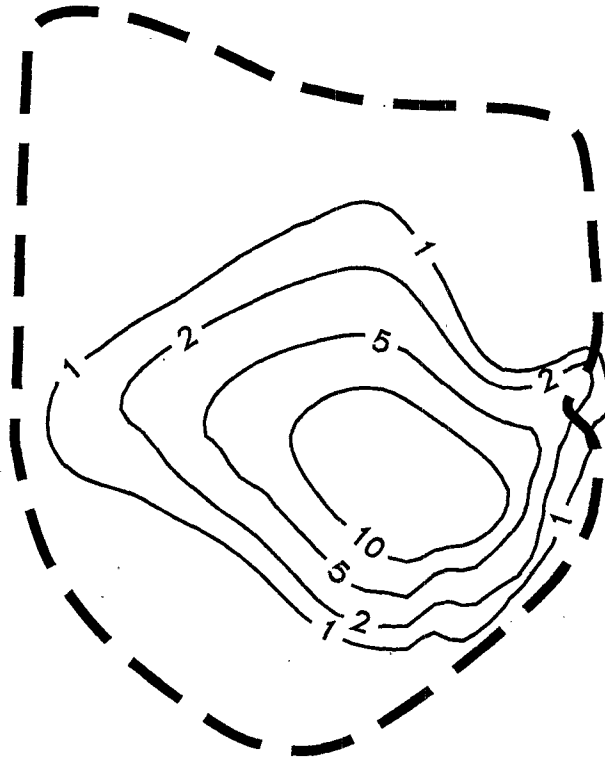
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BRDGSTN

FILE NO.: BRDGSTN

PRCT NO.: NP0344.001

DWG DATE: 06AUG98



LEGEND

TEMPORARY SURFACE WATER GAUGING LOCATION

MONITORING WELL AND DESIGNATION

TREE LINE

APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS

TRAILS

1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100

——— APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Saporlite, Year 2001
Single-Barrier Cover Alternative

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

4-7

AR312417

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

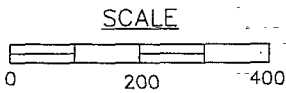
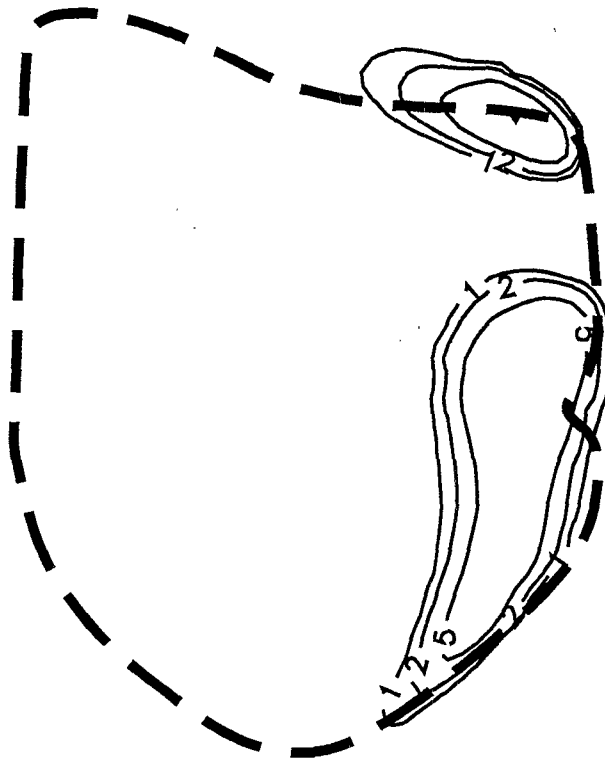
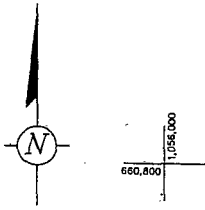
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BRDGSN

FILE NO: BRDGSN

PRJCT NO.: NPO344.001

DWG DATE: 06AUG98



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100
- — — APPROXIMATE LANDFILL BOUNDARY



**Predicted Vinyl Chloride Concentrations
in Bedrock, Year 2001
Single-Barrier Cover Alternative**

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
4-8

AR312418

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

DRAWING: SB10L1.DWG

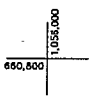
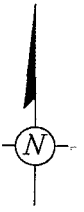
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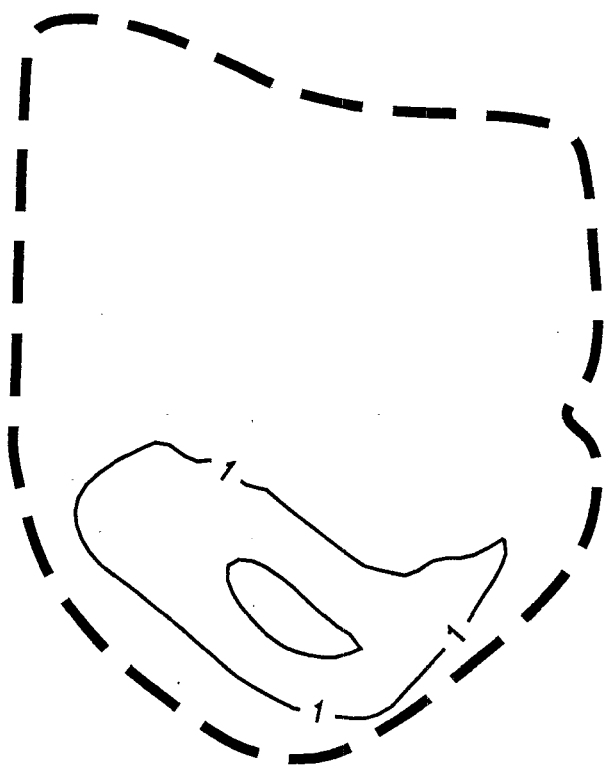
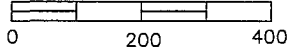
NP0344.001

PRCT NO.:

06AUG98



SCALE



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100
- APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Sapolite, Year 2006
Single-Barrier Cover Alternative
WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE
4-9

AR312419

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

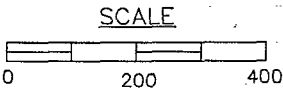
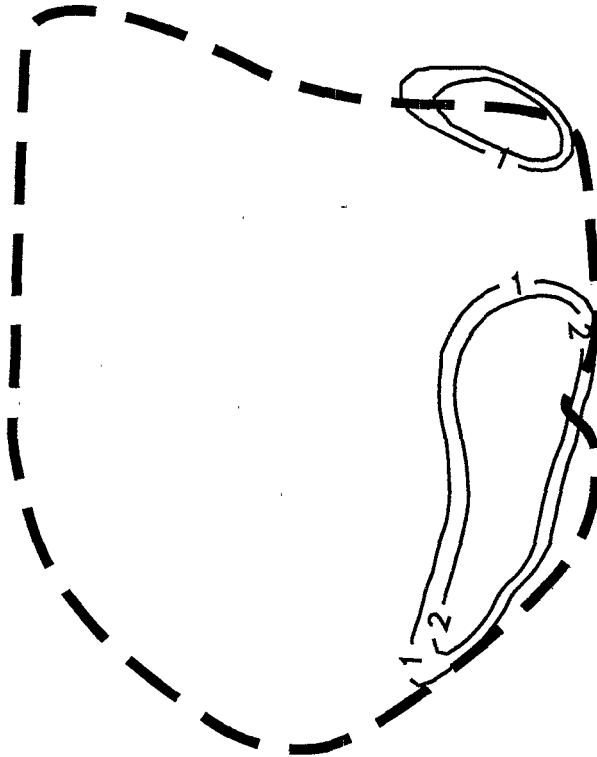
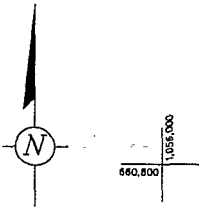
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FILE NO.:

PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100
- APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Bedrock, Year 2006
Single-Barrier Cover Alternative

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

4-10

AR312420

DRAFTER: JGJ

APPROVED: STP

CHECKED: STP

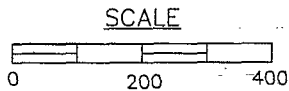
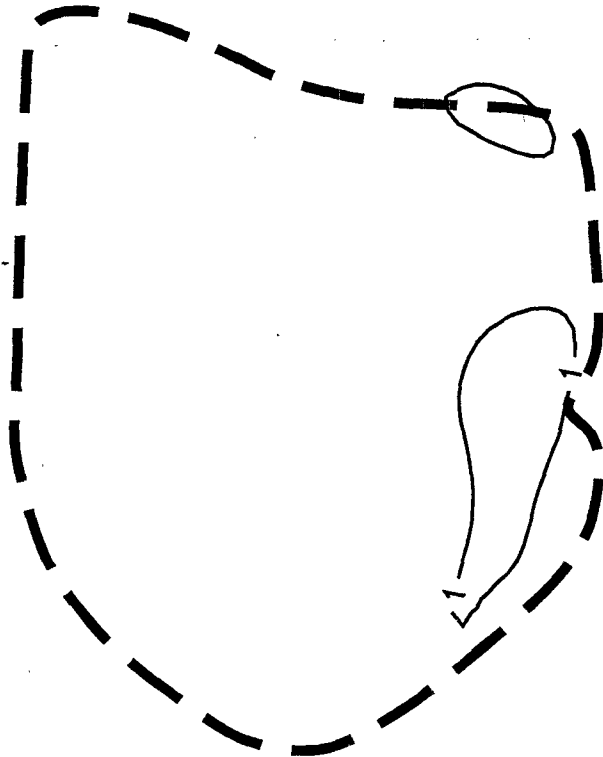
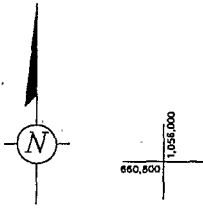
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FILE NO.:

PRJCT NO.: NP0344.001

DWG DATE: 06AUG98



LEGEND

- TEMPORARY SURFACE WATER GAUGING LOCATION
- MONITORING WELL AND DESIGNATION
- TREE LINE
- APPROXIMATE LOCATION OF PVC SLUDGE DISPOSAL CELLS
- TRAILS
- 1 ——— SIMULATED VINYL CHLORIDE CONCENTRATION (PPB)
CONTOURS SHOWN: 1, 2, 5, 10, 20, 50, 100.
- APPROXIMATE LANDFILL BOUNDARY



Predicted Vinyl Chloride Concentrations
in Bedrock, Year 2011
Single-Barrier Cover Alternative

WOODLAWN LANDFILL
Cecil County, Maryland

FIGURE

4-11

AR312421

Appendix A

**Opportunities for Wildlife Habitat Enhancement
at the Bridgestone/Firestone Woodlawn Landfill**

OPPORTUNITIES FOR
WILDLIFE HABITAT
ENHANCEMENT AT THE
BRIDGESTONE/FIRESTONE
WOODLAWN LANDFILL

REPORT SUBMITTED TO:
BRIDGESTONE/FIRESTONE
PORT DEPOSIT, MARYLAND

REPORT SUBMITTED BY:
WILDLIFE HABITAT COUNCIL
1010 WAYNE AVENUE
SUITE 920
SILVER SPRING, MD 20910

JULY 31, 1997

AR312423

Preparers of this report were:

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Acknowledgments:

The Wildlife Habitat Council (WHC) acknowledges the dedication and commitment required for Bridgestone/Firestone to initiate a wildlife habitat enhancement program at its Woodlawn site. We thank Bridgestone/Firestone for their hospitality during the WHC visit.

Note: This report is intended as a guidance tool for implementing wildlife habitat enhancement programs on corporate sites worldwide. WHC cannot assume responsibility for all local, state, and federal regulatory programs and authorizations. Prior to implementing any activity in a regulated habitat (i.e. wetland, floodplain, forest), we recommend that you reference regulatory requirements in your region. WHC can assist you with the identification of appropriate regulatory contacts.

Nondisclosure Statement: This document contains confidential and proprietary information. WHC will not distribute this report to others without express written consent from Bridgestone/Firestone. We also recommend that discretion be used when distributing this document to others.

AR312424

I. EXECUTIVE SUMMARY

Bridgestone/Firestone, Inc. recently joined the list of corporations actively involved as members of the Wildlife Habitat Council (WHC). The new partnership is coming to fruition with WHC assisting with a potential wildlife program that combines habitat improvement and community outreach at the Woodlawn Landfill in Port Deposit, Maryland. The Woodlawn Landfill is the first site Bridgestone/Firestone hopes to participate in WHC's *Wildlife at Work* program, which focuses on a company commitment, local community participation, and conservation organization support in the long-term, proactive management of property to benefit wildlife. This program also provides avenues to implement innovative land management practices and to increase environmental awareness in the community surrounding the site.

This report, *Opportunities for Wildlife Habitat Enhancement at the Woodlawn Landfill*, is based on a site visit conducted by a WHC biologist in June, 1997. The report is the result of an assessment of the site property, discussions with Bridgestone/Firestone personnel, and independent research. Recommendations for enhancing habitats and designing community outreach programs are included within this report, as well as methods for generating a solid foundation and participation within the proposed wildlife program.

Wildlife need four requirements from their habitat - food, water, cover, and space. This report outlines specific recommendations that provide and enhance these requirements at the Woodlawn Landfill. Recommendations include:

- erecting artificial nesting boxes for songbirds and wood ducks,
- placing raptor perches,
- building brush piles,
- rotationally mowing open areas,
- planting trees and shrubs to expand wooded corridors around the site,
- eradicating phragmites from the stormwater retention pond, and
- planting food plots.

The wildlife program can also serve as a great mechanism for increasing environmental awareness in the community and educating the public about the process of waste management. This can be accomplished by:

- combining habitat enhancement with educational programs that increase public awareness and demonstrate that those responsible for the site are good neighbors and responsible land stewards,
- inviting community groups to help implement habitat enhancement projects and aid in conducting wildlife surveys, and
- holding special "wildlife days" by offering activities such as tree plantings or building nature trails.

This report is the first step in long-term partnership between Bridgestone/Firestone and WHC. As the Woodlawn Landfill proceeds toward a potential *Wildlife at Work* program, WHC is available to provide additional guidance and technical assistance.

II. OVERVIEW

To best assist Bridgestone/Firestone in developing a program that meets the goals for the site, WHC visited the Woodlawn Landfill to learn the history of the site, talk with Bridgestone/Firestone personnel, overview the habitat types and determine potential options for managing the site for wildlife and increased environmental awareness.

A. Site Visit

WHC's visit to the site was conducted on June 26, 1997 by WHC Biologist Michael R. Hodge. Mike met with Tim Bent of Bridgestone/Firestone to review the habitats at the site and overview the remediation options for the contaminated landfill cell. Discussion began when Mike picked Tim up at the Baltimore/Washington Airport. During the drive to the Woodlawn Landfill, the history of the site was covered and the groundwork for the visit was established. Once arriving at the site, a brief driving tour was conducted around the perimeter of the property. Areas of the site walked and observed more closely were the landfill cell containing the Bridgestone/Firestone waste, the stormwater collection pond, the down gradient stream, and the site entrance.

The visit ended with initial ideas for developing the site for wildlife habitat and environmental awareness discussed during the drive back to the airport.

B. Site Description

The Woodlawn Landfill is located just north of Port Deposit, Maryland. It is directly adjacent to an active Cecil county waste transfer station. The south, west, and north borders are near residential properties while the eastern side is bordered by a county road.

Woodlawn is a closed landfill that was owned and operated by Cecil county. Bridgestone/Firestone was permitted to landfill waste from their nearby processing plant during the processing plant's operation. Upon closure of the processing plant, Bridgestone/Firestone was further permitted to landfill the remaining sludge from their lagoons in a specially designed landfill cell at Woodlawn. Since the closing of the landfill, contamination of local groundwater was discovered. The site is now listed on the Superfund NPL and is undergoing discussion as to future plans for the site.

Habitats on site include open areas, a stream, wooded corridors, and wetland areas. The site has a wide diversity of habitats and topography available to regional wildlife.

C. Wildlife on Site

The visit was conducted at about 2 o'clock on a hot day in June so few wildlife species were noted during the time on site. Despite the less than ideal situation for conducting a species inventory for animals, a scarlet tanager, kingbird, and wood thrush were all observed while on site. In addition, many other species were noted as occurring on site at other times. *Table 1* contains a representative list of some flora and fauna found at the Woodlawn Landfill site.

Table 1. Representative List of Wildlife Found at the Woodlawn Landfill

	Common Name	Scientific Name
Plants	black locust	<i>Robinia pseudoacacia</i>
	chestnut oak	<i>Quercus prinus</i>
	daisy fleabane	<i>Erigeron annuus</i>
	jack in the pulpit	<i>Arisaema triphyllum</i>
	mayapple	<i>Podophyllum peltatum</i>
	milkweed	<i>Asclepias</i> spp.
	multiflora rose	<i>Rosa multiflora</i>
	eastern red cedar	<i>Juniperus virginiana</i>
	phragmites	<i>Phragmites</i> spp.
	poison ivy	<i>Toxicodendron radicans</i>
	smooth sumac	<i>Rhus glabra</i>
	spicebush	<i>Lindera</i> spp.
	tulip poplar	<i>Liriodendron tulipifera</i>
	Animals	American robin
blue jay		<i>Cyanocitta cristata</i>
cottontail rabbit		<i>Sylvilagus floridanus</i>
gray squirrel		<i>Sciurus carolinensis</i>
house sparrow		<i>Passer domesticus</i>
kingbird		<i>Tyrannus</i> spp.
scarlet tanager		<i>Piranga olivacea</i>
white-tailed deer		<i>Odocoileus virginianus</i>
wild turkey		<i>Meleagris gallopavo</i>
wood thrush		<i>Hylocichla mustelina</i>

Because common names vary from region to region scientific names have been provided to assure consistency among species. A list of all species mentioned in this report can be found in *Appendix B* of this report.

III. DEVELOPING A HABITAT ENHANCEMENT PROGRAM

In order to assure a successful program with long lasting effects on wildlife and the local community, it is imperative that time and effort be spent developing the program. A strong basis will provide the impetus from which additional programs and projects can sprout. At the Woodlawn Landfill, this process needs to include local community groups, employees from the county, Bridgestone/Firestone monitoring personnel, and other interested parties.

However, before getting involved in the voluntary portion of the program, WHC recommends conducting a general clean-up of the site to prepare for the program. All excess trash and other unused materials should be removed prior to proceeding with an inventory or implementing an enhancement program. Once the site is free of excess trash, the projects outlined in the habitat enhancement section of this report should be used as a menu of options from which to choose when writing the management plan for the Woodlawn Landfill.

A. Conduct an Inventory

An initial step that is recommended prior to developing further plans for habitat enhancement is to conduct an inventory of plant and animal species currently found on site. This will provide baseline data for measuring future successes, increase the awareness of those participating in the inventories, and allow a wildlife team to determine which habitat components are missing for target wildlife species.

To accomplish the inventory, WHC recommends working with local bird watching groups to account for the avian portion of the inventory. Also, consult with neighbors and employees at the county transfer station to learn of

mammals, and invite a gardener or botanist to participate in developing a list of plant species found on the site.

When approaching potential partners it will be important to share the goals for the site and the need for developing an initial and future inventories. If a program is developed, inventories should be conducted seasonally to account for migratory birds and seasonal wildflowers. Inventory techniques can be found in *Appendix E*.

B. Hold an Initial Meeting

After the inventory is completed and a final decision is reached for the future of the site, WHC suggests reviewing ideas from this report and holding an initial meeting among invited guests from the community, local conservation groups, the Port Deposit planning department, the Cecil county landfill staff, and Bridgestone/Firestone employees. During the meeting it will be important to discuss the status of the site, the needs of the surrounding communities, goals for environmental education, wildlife habitat enhancement projects, and opportunities for community involvement.

C. Build a Wildlife Team

From the meeting it will be important to develop a wildlife team to decide which projects should be implemented, who will assist in getting projects completed, what the time frame for the program should be, and what the overall goals for the site should consist of. It is vital that the team be broad based to assure the greatest participation and ownership of the program. Members of local conservation groups and government agencies can provide local expertise whereas WHC can provide additional input and facilitation activities.

Employees from the transfer station could also be asked to join the team. During WHC's site visit the county employee at the transfer station shared a strong interest in the outdoors and wildlife. Finding individuals with an interest in the outdoors, hunting, fishing, bird watching, gardening, and education is unequivocally the most important portion of a long term program with active involvement. Please be aware that it is not necessary to have any degree of expertise to be a part of the team. More experienced team members can teach others less versed in understanding ecosystems and the wildlife at the site.

D. Write a Management Plan

The management plan provides the formal document to be used when determining the direction of the program. It is recommended that it be arranged to list goals, objectives, and prescriptions. These are best arranged in an outline fashion where the goals are the most inclusive and the prescriptions describe exactly what is to be done and when.

Management plans are also simple documents used to maintain the direction of the program and to share with new groups interested in the program. When the goals and objectives of the program are outlined in a readable document, it becomes easier to demonstrate the large scheme of the program as well as why individual projects are implemented.

IV. HABITAT ENHANCEMENT OPPORTUNITIES

The Woodlawn Landfill presents a number of opportunities for managing for wildlife. A variety of habitats including a stream, open fields, wooded corridors,

and a stormwater retention pond offer considerable resources for wildlife. Enhancing these habitats and providing the four essential requirements for all wildlife; food, water, cover, and space, is essential in any well conceived wildlife management plan. If these living requirements are provided, the wildlife team will be providing the means for increasing biodiversity at the site. Increased biodiversity should be the underlining goal of all habitat management projects and programs developed at the Woodlawn Landfill.

A. Erect Nest Boxes

Due to loss of habitat, some bird species lack adequate nesting places. One group of birds that can be easily helped is the cavity nesters. These birds typically nest in cavities left in snags (dead standing trees) by woodpeckers or other creatures. The cavities are then occupied by a nesting pair of adults to raise one or more broods each nesting season. However due to development and other land management practices, many snags have been removed therefore leaving few ideal nesting places for cavity nesters.

A supplemental source of these nesting cavities can be provided at the Woodlawn Landfill by erecting artificial nesting cavities known as bird boxes. Boxes are designed to mimic the natural cavity size for the target species. Much success has been achieved in reviving the numbers of bird species once on the decline. A common nest box user that is a good example is the eastern bluebird. Once a species with declining numbers, the efforts of nest monitors have contributed significantly to the rebound of the species. Last year alone WHC sites reported the fledgling of over 3,400 bluebirds from artificial nesting cavities erected at corporate sites with wildlife habitat management programs. Other species will also readily use properly designed nest boxes if placed in the correct habitat. WHC recommends that Bridgestone/Firestone encourage the use of

nest boxes at the Woodlawn Landfill to assist populations of native birds and to provide an opportunity for hands-on education for those assisting and monitoring the program.

Careful monitoring of nest boxes will also allow the site to participate in WHC's *Nest Monitoring Program*. This program compiles data on birds nesting on WHC sites throughout the United States, thus documenting the number of birds hatched and fledged each breeding season. In 1996, for example, over 12,375 young birds were fledged at participating corporate sites. Each year this data is compiled in a *Nest Monitoring Program* summary, a copy of which is included in the pocket of the black three ring binder version of this report. Additional copies are available from WHC at no charge.

1. Manage for Eastern Bluebird

The eastern bluebird has historically suffered in numbers, and the lack of suitable nesting cavities typically found in snags is a continued threat to the species. Ideal eastern bluebird habitat includes open sites such as fields, pastures, and mowed areas with scattered trees for perching.

a) Place Nest Boxes

The Woodlawn Landfill has many ideal areas for bluebird boxes especially the open areas of the landfill cap and the adjoining property that was purchased by Bridgestone/Firestone. Because bluebirds are very territorial, bluebird boxes should be placed at least 100 yards apart. Bluebirds prefer to have some type of perch (i.e. a shrub or small tree) located several yards in front of the entrance to their nest box. The young birds often fly to this perch on their first flight and adults will use the perch to hunt for insects.

WHC recommends that the team members start by installing ten or twelve boxes around the landfill and adjacent Bridgestone/Firestone property. The boxes should be in locations that are easy to monitor so it is recommended that they be placed near the perimeter roads. As interest in the program grows, program participants may be able to monitor more boxes, and additional boxes can be installed in other areas of the site. More information on eastern bluebird management can be found in *Appendix E*.

(i) Monitoring Information

Maintenance and monitoring of nest boxes is essential to success. Ideally, songbird boxes should be monitored weekly during the nesting season, and only as many boxes that are able to be regularly monitored should be erected. Monitoring provides data that can be used to track the success of the program and will allow the team members to avert problems such as predation by snakes and raccoons. If predation is found to be a problem, predator guards should be placed on nest box posts. See the design in the *Eastern Bluebird Habitat Management Series* in *Appendix E* for details.

Monitoring will also prevent competitive species from using the nest boxes. Invasive species, such as the European starling and house sparrow compete for nesting sites with other cavity-nesting birds, often going as far as destroying the eggs and young of their victims. By monitoring nest boxes regularly, nests and eggs of the starling and sparrow can be removed before they become productive. If these species are found to inhabit the boxes, the adults can be trapped and removed from the nest boxes. If team members are uncomfortable with this approach, they may vigorously shake the eggs (a technique called addling), rendering them inviable. The adult bird will return and continue to sit on the eggs, which will prevent it from disturbing the nests of native birds, but the eggs will not hatch.

Caution must be taken to positively identify the birds and eggs as those of the house sparrow (*Passer domesticus*) or European starling (*Sturnus vulgaris*) before adding. Native songbirds are legally protected under the Federal Migratory Bird Conservation Act, which prohibits the possession or taking of birds, nests, eggs, or parts thereof. The house sparrow and European starling are not protected under this law.

2. Manage for Tree Swallows

Tree swallows are another species that commonly use nest boxes placed in open areas. They are also very attracted to water sources and will commonly be seen feeding on insects close to the water's surface. As with bluebirds, the lack of suitable nesting sites is a limiting factor in the success of the tree swallows reproduction. Similar care should be taken when monitoring these boxes as snakes, raccoons, European starling, and English sparrow are also common predators or competition of the tree swallow.

Tree swallows will use habitats similar to the eastern bluebird but prefer more open water. They will however also use upland habitats and are compatible with bluebird nesting programs. WHC recommends placing up to ten nesting boxes around the landfill area to attract nesting pairs of tree swallows to the site. Additional information about managing for tree swallows is included in the *Tree Swallow Habitat Management Series* located in *Appendix E*.

3. Place a Wood Duck Box at the Stormwater Pond

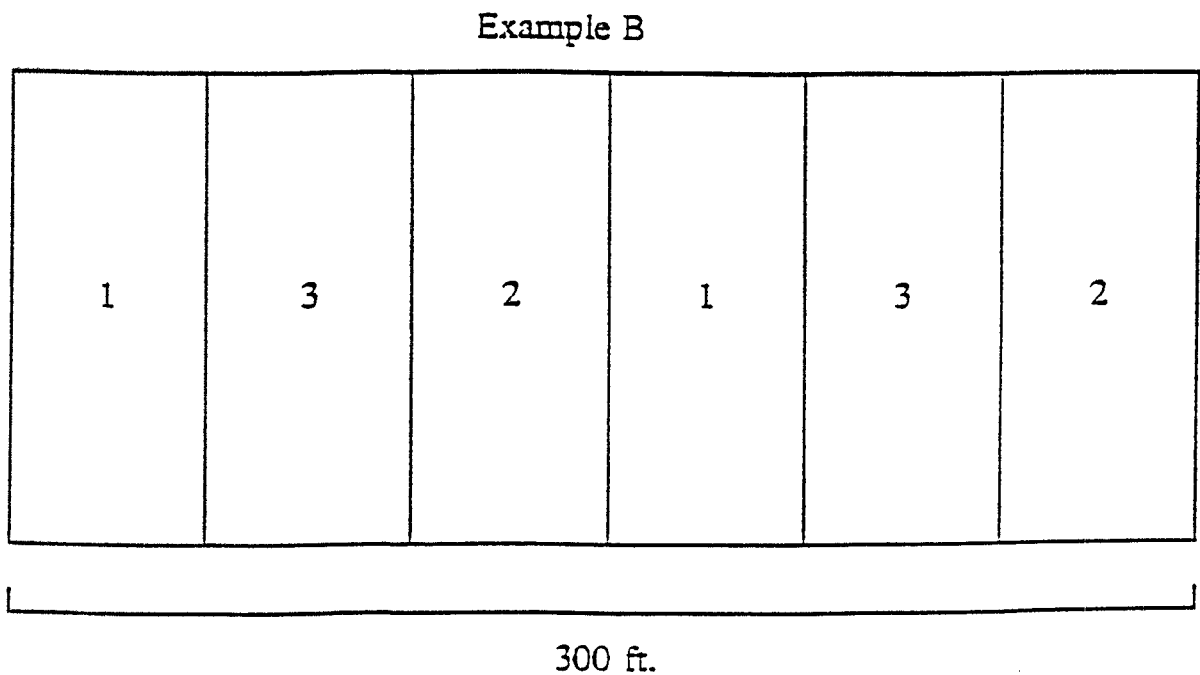
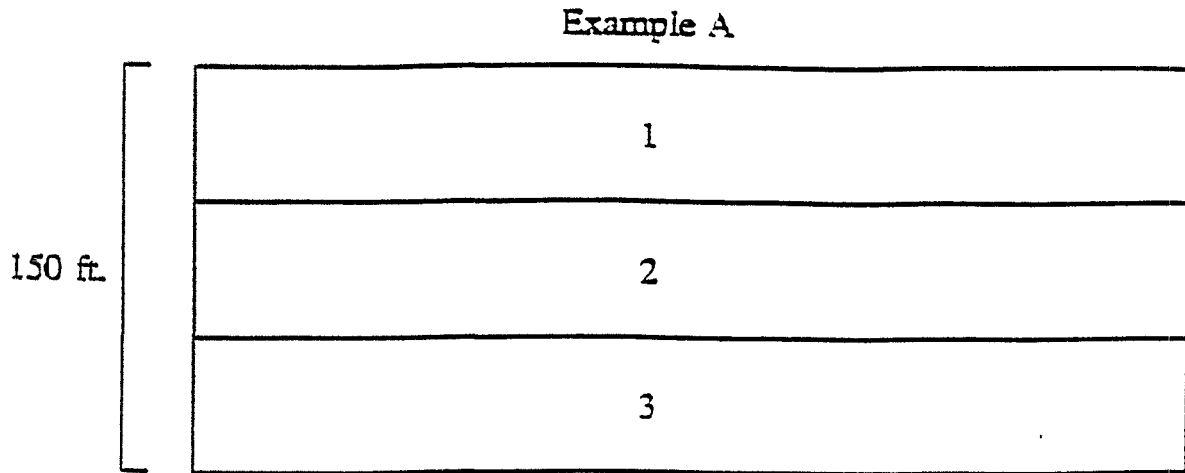
Wood ducks are very colorful birds that prefer wooded wetlands, marshes, stream beds, and ponds for nesting habitat. Wood ducks also provide another good example of how the efforts of nest monitors assisted in the comeback from near extinction. Today their numbers are flourishing.

Their diet consists primarily of seeds, acorns, berries, and insects. The food sources and other components could be provided at the Woodlawn Landfill at the stormwater retention pond. If the pond is cleared of the abundant phragmites, it could provide suitable habitat for attracting wood ducks to use the site. Currently the amount of open water is too limited to provide good wood duck habitat. However with the enhancement of the pond and the presence of a nearby stream this area could house wood ducks in the future.

Once the program proceeds and members of the team are looking to expand the program, WHC recommends placing one wood duck box on the pond shoreline to attract a nesting pair to the site. Additional information about the wood duck and its management can be found in the *Wood Duck Habitat Management Series* located in *Appendix E* of this report.

B. Develop a Rotational Mowing Schedule

Currently, both the capped portion of the landfill and the adjoining property are not maintained with regular mowing. These areas consist of a variety of grassy areas with intermittent shrub growth. The lack of mowing has resulted in improved wildlife habitat as more cover and food sources have become available with increased growth. However landfill caps often require occasional mowing to prohibit the establishment of woody vegetation and to aid in monitoring activities. If mowing is required at the Woodlawn Landfill, WHC recommends that the team implement a rotational mowing schedule. In addition, to enhance food and cover sources for wildlife at the site as a whole, similar techniques could be implemented on the adjacent land regardless.



Examples of rotational mowing regimes. Numbers depict the year that each section is mowed. Example A is a smaller field where only three strips are necessary, and example B is a larger field that is divided into six strips. Notice that by the third year each strip has been mowed at least once.

Figure 1. Rotational Mowing

To establish a rotational mowing scheme, divide a designated area into three strips no less than 50 feet in width and clearly mark areas to be mowed. This will prove valuable when demonstrating through educational materials the value of this management strategy. Strips less than 50 feet do not allow small prey animals adequate protective cover. The strips should be mowed once annually in a rotational pattern. For example, given three strips, the first is mowed one year, and the other two are left unmowed. The second year, another strip is mowed, leaving the first and third unmowed. The third year, the third strip is mowed, leaving the first and second to grow. After the third year, the process begins again. Mowing should take place in the late fall to avoid affecting the feeding and nesting of wildlife. Examples of rotational mowing patterns are depicted in *Figure 1*.

While preventing the establishment of deep-rooting woody vegetation, the primary advantage of rotational mowing as a management tool is to create a variety of grass heights, each of which benefits wildlife in a different way. New grass growth provides forage for small mammals and attracts insects which are preyed upon by songbirds and small raptors. Taller grasses provide food and cover for small mammals and nesting sites for songbirds. Small mammals and birds attracted to the area may also provide a food source for red-tailed hawks, foxes, and other predators. In addition to the habitat benefits, rotational mowing also serves as an excellent educational tool for teaching the ecological principles of old field succession.

C. Place Raptor Perches

The landfill and the adjacent Bridgestone/Firestone land are probably inhabited by small mammals, which are food items for raptors, or birds-of-prey. Many raptors, including red-tailed hawks, locate food by surveying an area from high

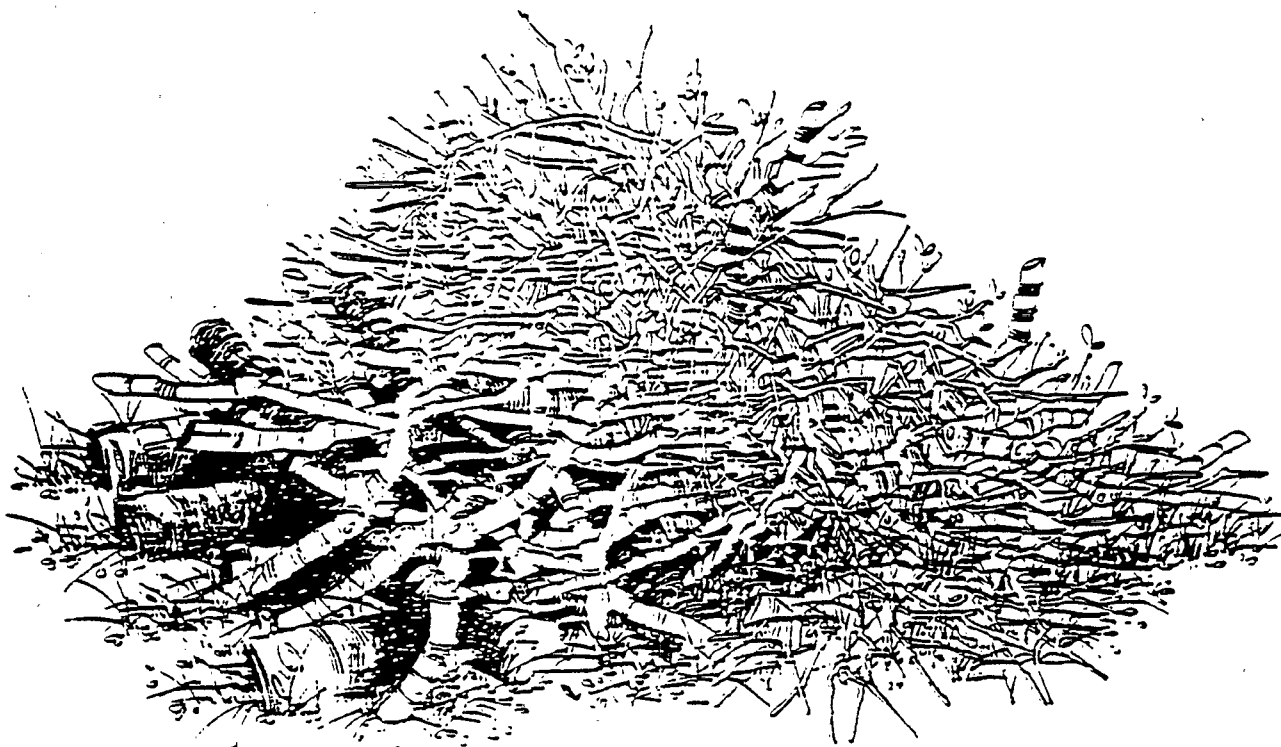
branches or tall structures. In addition to giving the raptor a wide visual range, perching in a high place enables an easier takeoff and greater attack speed for the raptor when hunting. Raptor perches can be constructed to facilitate hunting by red-tailed hawks and other raptors on the site. A raptor perch can be created by erecting a 16 to 20 foot long 4" x 4" post with a crossbeam at the top. The lower three to four feet of the post should be buried in the ground and additional braces may be required for stability. Old telephone poles can be substituted for the 4" x 4" post.

WHC recommends placing two raptor perches, one at the edge of the landfill opposite the site entrance, and the other on the adjacent property. Raptor perches can be monitored by watching them from a distance and looking for signs such as droppings and animal remains around their bases. Encouraging use of the capped area by raptors could also help control populations of burrowing animals. Further information about constructing raptor perches can be found in the *Raptor Perches Habitat Management Series in Appendix E*.

D. Build Brush Piles

Brush piles can be built to encourage use of the site by wildlife such as rabbits and other ground dwelling mammals. Brush piles will be used by small animals as a refuge from predators and inclement weather if the piles are within 75 feet of other shelter. However, these animals will be exposed to predators as they travel to and from the piles creating a balance with the raptor perch project. By building brush piles, the team can support both predator and prey species.

Brush piles are very easy to construct using dead branches and other natural materials. The largest pieces of wood should be used to create a base, and then smaller branches and twigs can be piled on top. *Figure 2* is an illustration of a



(Adapted from: "Enhancement of Wildlife Habitats on Private Lands." Daniel J. Decker and John W. Kelly, 1988)

Figure 2. Brush Piles

brush pile. Several brush piles can be built around the open areas of the landfill and adjacent fields. Occasional observations can be made of animal scat and tracks near the piles to determine use. Further information about brush pile construction can be found in the *Brush Piles for Wildlife Habitat Management Series* in *Appendix E*.

E. Expand Wooded Corridors

Much of the Woodlawn site is open because of the landfill or what seems to be previous farming of the adjacent property, however, several wooded corridors that provide very valuable habitat for large mammals and many songbirds surround the Woodlawn Landfill. In an effort to build on these habitats and provide additional benefits to the Woodlawn site, it is suggested that tree seedlings be planted to expand upon the currently wooded areas. Planting seedlings is a low cost activity that results in increased wildlife habitat, hands-on activities for all groups involved, and an excellent demonstration for projects that can be implemented at other similar sites.

When planting the corridor, WHC recommends using a variety of seedlings to create initial results and plan for long term benefits. It should be noted that trees and shrubs should not be planted in straight rows but in staggering rows to create a natural setting. A list of native trees and shrubs that could be planted to expand the corridor and create additional buffer is included in *Table 2*.

Table 2. Native Trees for Expanding Wooded Corridors

Trees	American beech	<i>Fagus grandifolia</i>
	blackgum	<i>Nyssa sylvatica</i>
	Canadian hemlock	<i>Tsuga canadensis</i>
	red oak	<i>Quercus rubra</i>
	sweetgum	<i>Liquidambar styraciflua</i>
	white oak	<i>Quercus alba</i>
Shrubs	winterberry holly	<i>Ilex verticillata</i>
	bayberry	<i>Myrica</i> spp.
	highbush blueberry	<i>Vaccinium corymbosum</i>
	possumhaw viburnum	<i>Viburnum nudum</i>
	redosier dogwood	<i>Cornus serotina</i>
	serviceberry	<i>Amelanchier arborea</i>

This project should be carefully coordinated and planned with the meadow planting recommended later in this report and the rotational mowing schedule. Areas planted with seedlings need to be clearly flagged to assure that newly planted seedlings are not mowed or disturbed by other planting initiatives.

F. Create a Wildflower Meadow

Wildflower meadows are aesthetically pleasing and provide valuable wildlife habitat. They consist of food and cover as well as nesting spots for many species of butterflies, hummingbirds, songbirds, and small mammals. A wildflower meadow could be designed and planted in the area currently occupied by empty drums and also near the entrance to the site. Wildflowers develop extensive root systems which are also very valuable at holding soil in place to reduce erosion and excess runoff. The combination of functionality and improved wildlife

habitat provide an appealing consideration for the future use of this area of the site. Completed in conjunction with the other options presented in this report, this option could provide a very valuable wildlife sanctuary that could be used to demonstrate to others the value of active management and the use of native plants.

In addition, landscaping practices could be done in conjunction with the U.S. Fish and Wildlife Service's Bayscapes Program. This program is intended to raise awareness of beneficial landscape practices within the Chesapeake Bay watershed. Additional information is included in *Appendix E*.

1. Creating a Wildflower Meadow

Careful site preparation is essential to wildflower meadow success as new planting areas must be free of weeds and grasses. To prepare undisturbed areas for seeding, WHC recommends disking the soil at the designated planting area, spraying with a non-persistent glyphosate herbicide, such as *Roundup*, then planting the seeds in early spring (*Rodeo* is recommended in areas that may be wet or are near wetlands). It may be necessary to keep the seeds in a cold place such as outside or in a freezer until spring because many wildflower seeds need winter cold to break their dormancy period.

After the planting area is prepared, seed the meadow with the wildflower mix in early spring. The overall seed mix, including grasses and wildflowers, should be distributed at a rate of 15 pounds per acre and include a 60% grass and 40% wildflower mix. To make spreading the mix easier, seed should be mixed with an inert bulking agent, such as saw dust that has been lightly dampened. This will ensure proper distribution of the seed. Mix 1 part seed to 3 parts bulking agent.

Because wildflower and grass seeds require good seed-to-soil contact, lightly rake and then roll the seeded area after seeding. If rainfall is inadequate to keep the soil moist, regular early morning watering during the first four to six weeks (and beyond if drought conditions exist) will result in a higher germination rate. Water the seeded area just enough to keep the soil moist; be careful not to over water.

2. Species Selection

WHC recommends planting wildflowers and grasses that are native to Maryland because many exotic species can become invasive and limit the natural diversity of the area. Table 3 lists some valuable native grasses and wildflowers that can be planted at the Woodlawn Landfill.

Table 3. List of Native Grasses and Wildflowers for the Woodlawn Landfill

GRASSES			
broom sedge <i>Andropogon virginicus</i>	purple love grass <i>Eragrostis spectabilis</i>	little bluestem <i>Andropogon scoparius</i>	switchgrass <i>Panicum virgatum</i>
june grass <i>Koeleria cristata</i>	side-oats grama <i>Bouteloua curpendula</i>	meadow fescue <i>Festuca elatior</i>	

Table 3: continued

WILDFLOWERS			
Name	Blooming Time	Color	Soil Moisture
beard tongue ⁷ <i>Penstemon digitalis</i>	spring	white	medium
columbine ⁷ <i>Aquilegia canadensis</i>	spring	red	dry-medium
dwarf crested iris ⁷ <i>Iris cristata</i>	spring	purple	dry medium
wild geranium ⁷ <i>Geranium maculatum</i>	spring	pink/purple	moist
bee balm ⁷ <i>Monarda didyma</i>	summer	red	moist
black-eyed susan ⁷ <i>Rudbeckia hirta</i>	summer	yellow	dry-medium
butterfly weed ⁷ <i>Asclepias tuberosa</i>	summer	orange	dry
dense blazing star <i>Liatris spicata</i>	summer	lavender	wet-medium
lance-leaved coreopsis ⁷ <i>Coeropsis lanceolata</i>	summer	yellow	dry
shooting star ⁷ <i>Dodecatheon meadia</i>	summer	pink	dry-moist
swamp sunflower ⁷ <i>Helianthus ausustifolius</i>	summer	yellow	medium
evening primrose <i>Oenothera biennis</i>	summer, fall	yellow	dry-medium
blue aster <i>Aster azureus</i>	fall	blue/violet	dry-medium
New England aster ⁷ <i>Aster novae-angliae</i>	fall	lavender	moist-medium
New England blazing star <i>Liatris borealis</i>	fall	pink/red	wet-medium
purple coneflower ⁷ <i>Enchinacea purpurea</i>	fall	purple	dry-medium

H - hardy, reliable species

S - shade tolerant, good for planting along wooded edge

A list of seed sources can be found in Appendix C.

3. Maintenance and Monitoring of Meadows

During the first year after seeding, weed control will be critical. Perennial wildflowers and grasses spend most of their energy during the first year establishing root systems and therefore grow slowly. Weeds, however, grow much more quickly than the desirable wildflowers. When weeds have reached a

height of 12 to 16 inches, they should be mowed back to 6 to 8 inches (most desirable planted species will not be taller than 6 inches during the first year). Brush hogs and weed eaters work best because they lay cuttings down so that they will dry out and not smother wildflower seedlings. The frequency of mowing during the first year will depend upon weed density, but should be about once every two months. Once established, the meadow should only need to be maintained by annual mowing. Ideally, the area should be mowed in late winter (November) to avoid disturbing nests and young animals. More information on wildflower meadows is included in *Appendix E* in the *Wildflower Meadow Habitat Management Series*.

G. Plant Food Plots

Food plots have traditionally been popular tools of wildlife managers for attracting wildlife to specific sites. Their role as a supplemental food source can be debated however the value created by the increased viewing opportunities can be significant. Agricultural practices have also played a significant role in the history and culture of North America's east coast. Therefore several small food plots in the back corner of the Bridgestone/Firestone property would be a nice addition to the whole wildlife program package at the Woodlawn Landfill site. The food crop should not be harvested but left as a winter food source for the wildlife remaining on site. WHC recommends several one acre areas designated to food crops. In these areas, corn, grain sorghum, lespedeza, or clover could be planted each year to attract wildlife to the site. Each area should be clearly marked and noted as a food plot for wildlife.

H. Control Phragmites in the Stormwater Retention Pond

Phragmites is an invasive reed grass with little value to wildlife. Phragmites can take over an area very rapidly, excluding all native plants which may have higher values to wildlife. The phragmites stands at the stormwater retention pond have choked the wet area to the point that very little open water is available to local wildlife. If the area is to be enhanced for wildlife and educational purposes, it is recommended that the stand of phragmites be eradicated.

The most effective way to control phragmites is to use a non-persistent herbicide such as glyphosate on the plants, followed by mowing. Glyphosate should be sprayed directly onto the plants in late summer, when the plants are transporting nutrients into their root systems for winter use. Care should be taken so that non-target plants are not subjected to the herbicide. After waiting six to eight weeks for the herbicide to achieve its full effect, the phragmites should be cut down as low as possible. This mowing may have to be repeated several times before the phragmites are eradicated. After initial eradication, monitoring will be important to assure that the phragmites does not become re-established after initial enhancement activities. Further information about controlling phragmites can be found on the *Common Reed Grass* sheet and the *Wetlands Invaders Habitat Management Series* located in *Appendix E*.

V. OPPORTUNITIES TO INCREASE ENVIRONMENTAL AWARENESS AND CONTRIBUTE TO ENVIRONMENTAL EDUCATION

The location of the Woodlawn Landfill adjacent to the Cecil county waste transfer station presents an excellent opportunity to create a demonstration area

for explaining the landfill process and the destination of trash created by residents of the local community and tourists passing through the Port Deposit area. The educational component can be closely tied to the function and monitoring of the closed site as well as the habitat enhancement portion of the program to demonstrate that a proactive approach to maintenance and monitoring can result in valuable learning opportunities.

A. Construct a Nature Trail

Trails are great for raising awareness and education levels of chosen themes or curriculums by providing hands on learning experiences that cannot be achieved in the classroom alone. They are also very valuable in continuing education for adults interested in furthering their knowledge of the natural world and other specific learning experiences that can be supplemented with field work. For this reason it could be advantageous to use the closed landfill as a demonstration of the relationship of waste management and the surrounding environment.

1. Create Trail Loops

When creating the best interpretive trails it is important to incorporate loops. Loops lend the trails to multiple groups without the distraction of retracing the same portion of trail or running into additional groups while traversing the trail path. A variety of loops with different lengths can also tailor to a number of age groups, attention spans, and time restraints. For the Woodlawn Landfill and surrounding grounds it is recommended that three loops be flagged and created. They could begin near the entrance at the transfer station to incorporate the relationship between the landfill, current recycling and disposal activities, and the natural environment. If traffic may create a potential negative to this entrance, the roadway on the adjacent Bridgestone/Firestone property could be

enhanced to handle traffic to the educational areas but the relationship to the active trash disposal should not be lost.

2. Traverse Through a Variety of Habitats

The property at the Woodlawn landfill contains a number of habitat types that possess different qualities and wildlife habitat. It is important to capitalize on this diversity to provide the optimal learning environment. Habitat types that could be highlighted include the old farm area that lies adjacent to the landfill to the north. By implementing some of the previously mentioned habitat enhancement projects the old farm area could be used to highlight best management practices of agriculture as well as food plots used to attract wildlife. Other areas of interest could be the extended wooded corridor running the boundary of the property, the landfill proper, and areas near the stream down hill of the landfill. During WHC's visit a variety of wildlife was noticed along the stream corridor. This could easily be taken advantage of without impeding upon the integrity of the current habitat or stream quality. Trails near the stream should remain away from the streambank but could incorporate an overlook that adequately provides a view of the water and associated wildlife of this area.

3. Use Interpretive Materials

To accomplish the goal of informing trail users about the natural environment and impact of necessary practices of waste management, it is critical that interpretive materials be provided along the trail loops. Signs and trail maps are very important to keep the attention of the participants on the theme at hand. Interpretive materials could focus on habitat requirements of all wildlife such as water, cover, food, and space. Relationships of these habitat to different wildlife species and how they use each habitat to support their day to day activities could be explained at stops along the trail. Although wildlife components are recommended as a focus, the landfill activity and function should not be

disregarded. For a truly beneficial trail system to work at the Woodlawn Landfill, the compatibility of the landfill and surrounding environment should be apparent. Landfill technology has advanced considerably since its inception and this project could provide a means of studying the potential final use of a landfill post closure. It could also be effective in educating the users of the transfer station as to their impact on the environment and demonstrating an example of a final resting place of the waste created at their homes.

Including a portion of the site near the transfer station to promote recycling efforts would also add to the value of the educational experience provided by the habitat management program at the landfill. Slogans such as Reduce, Reuse, and Recycle could be used to educate the importance of reducing the waste stream. This would provide an important role in increasing the awareness of the residents of Port Deposit as well as tourists traveling through the area.

B. Establish an Education Center

Materials such as water sampling kits, microscopes, field guides, binoculars, and literature about wildlife, natural processes, and the landfill business could be provided in an education facility provided at the site. Browning Ferris Industries' Conestoga Landfill in Morgantown, Pennsylvania has implemented a similar program at their active landfill to demonstrate the current technology of waste management and the compatibility to the environment. A similar concept could be adopted at the Woodlawn Landfill to demonstrate the final closure of a landfill and the potential future uses of landfills as wildlife habitat. Closed landfills can provide many of the habitat requirements of wildlife and this could be highlighted at the educational center.

Educational facilities can range from newly built centers to trailers designed to handle small groups of visitors. Materials about agricultural practices, landfill operations, wildlife habitat, and environmental quality could be addressed and provided to organized groups visiting the site. A log of visitors would be important to document the site's use and to account for the groups being reached by the educational efforts of everyone involved at the site.

Because the site is listed as Superfund, visitors should first be invited to tour the site by appointment only. This will allow liability issues to be better managed and will assure the site is being used for the targeted environmental education needs. Once a program is developed further, additional access may be granted. U.S. Steel Group has developed a program at their South Taylor Environmental Park outside of Pittsburgh, Pennsylvania that allows unlimited access to select teachers and school groups involved in the program since its inception. The South Taylor Environmental Park is a landfill operation where a pavilion was constructed as an education area for school groups visiting the wetland mitigation site associated with the landfill operations. Additional community access could also be arranged at the Woodlawn Landfill as future management of the site is determined.

VI. WHC'S CORPORATE WILDLIFE HABITAT CERTIFICATION PROGRAM

WHC provides certification for corporate and industrial sites that demonstrate a long-term commitment to managing for wildlife and increasing biodiversity in their area. Once the team at the Woodlawn Landfill has implemented, monitored, maintained, and documented projects that enhance wildlife habitat for at least one year, Bridgestone/Firestone may be eligible to apply for

certification through WHC's *Corporate Wildlife Habitat Certification/International Accreditation* program. Descriptions of certified projects are published in WHC's *International Registry of Certified Corporate Wildlife Habitats* and press releases are distributed to local and national news contacts. Certified sites also receive an award plaque and are honored at WHC's Annual Symposium.

In order to be eligible for certification, the program at Woodlawn Landfill must conduct an ongoing animal and plant species inventory. This will show how the wildlife habitat enhancement program is affecting the local ecosystem. A wildlife habitat management plan that outlines goals for the site and the methods that will be used to accomplish those goals is required. All enhancement projects must be carefully documented as well. Once a site has achieved certification, it must apply for recertification every two years to ensure that the commitment to creating wildlife habitat is long-term. More information about certification can be found in *Appendix D*.

VII. SUGGESTED IMPLEMENTATION SCHEDULE

To assure a successful program it is often advantageous to begin with small, highly successful projects that create valuable wildlife habitat. The following implementation schedule is only a sample. Actual implementation will depend upon interest and schedules of interested groups, funding, and time of year.

Year 1

Program Development

1. Develop a wildlife inventory

2. Write a management plan reflecting future uses of the site
3. Contact interested participants to join the wildlife management of the landfill

Habitat Projects

1. Begin rotational mowing practices in open areas
2. Plant food plots on the adjacent Bridgestone/Firestone property
3. Build brush piles in open areas
4. Erect nesting structures around the perimeter of the property

Year 2

Program Development

1. Update the wildlife inventory
2. Make adjustment to wildlife management plan to reflect changes in the program
3. Contact groups interested in the educational component of the program

Habitat Projects

1. Plant a wildflower meadow
2. Control Phragmites in the retention pond
3. Erect raptor perch poles
4. Expand wooded corridors around the site
5. Monitor nesting structures

Year 3

Program Development

1. Construct the nature trail
2. Place interpretive materials
3. Create an environmental education center

Habitat Projects

1. Landscape education center with plants native to the site and valuable to wildlife habitat

2. Participate in the U.S. Fish and Wildlife Services Bayscapes Program
3. Continue monitoring nesting structures

VIII. SUMMARY

Of the many Bridgestone/Firestone sites, the Woodlawn Landfill is the first to consider a habitat enhancement program in association with the Wildlife Habitat Council (WHC). This report was prepared to provide wildlife habitat enhancement and community outreach recommendations for the Woodlawn Landfill. Bridgestone/Firestone could start by holding an initial meeting with regulatory agencies, Cecil county employees, community groups, and Bridgestone/Firestone personnel to spark interest in the program.

Once established, the wildlife team determining the future use of the site should select a specific project to implement as the first step in a long range wildlife habitat program. Recommendations for habitat enhancement at the Woodlawn Landfill include:

- Erecting nesting structures for bluebirds and tree swallows
- Expanding wooded corridors around the site
- Building brush piles
- Rotationally mowing portions of the site
- Creating a wildflower meadow
- Placing raptor perching structures
- Controlling Phragmites
- Planting agricultural food plots for wildlife

In addition to habitat enhancement, environmental education programs are recommended to make visitors to the site and the county transfer station aware of waste management and the potential compatibility of closed landfills and

wildlife habitat. Recommended projects for raising environmental awareness include the following.

- Utilize the Cecil county transfer station to highlight the management of the site
- Create a nature trail
- Provide interpretive materials
- Develop an environmental education center

After some of the projects have been established for at least one year, the Woodlawn Landfill wildlife management program may be eligible for WHC certification to receive recognition for the proactive management efforts on behalf of wildlife. To achieve program certification, a habitat management plan, documentation of implemented projects including photo documentation, and a log book should be submitted. Other materials that may be required are listed on the certification application form provided in *Appendix D* of this report.

WHC views this report as the first step in long-term partnership with Bridgestone/Firestone, Inc. We look forward to working with the employees, regulatory agencies, and community groups to achieve environmental goals at the Woodlawn Landfill and at Bridgestone/Firestone facilities throughout the United States.

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY 1

II. OVERVIEW 3

 A. Site Visit..... 3

 B. Site Description..... 4

 C. Wildlife on Site 4

III. DEVELOPING A HABITAT ENHANCEMENT PROGRAM..... 6

 A. Conduct an Inventory 6

 B. Hold an Initial Meeting..... 7

 C. Build a Wildlife Team 7

 D. Write a Management Plan 8

IV. HABITAT ENHANCEMENT OPPORTUNITIES 8

 A. Erect Nest Boxes..... 9

 1. Manage for Eastern Bluebird..... 10

 2. Manage for Tree Swallows 12

 3. Place a Wood Duck Box at the Stormwater Pond 12

 B. Develop a Rotational Mowing Schedule..... 13

 C. Place Raptor Perches..... 14

 D. Build Brush Piles 15

 E. Expand Wooded Corridors 16

 F. Create a Wildflower Meadow 17

 1. Creating a Wildflower Meadow 18

 2. Species Selection..... 19

 3. Maintenance and Monitoring of Meadows..... 20

 G. Plant Food Plots..... 21

 H. Control Phragmites in the Stormwater Retention Pond 22

V. OPPORTUNITIES TO INCREASE ENVIRONMENTAL AWARENESS AND
CONTRIBUTE TO ENVIRONMENTAL EDUCATION 22

 A. Construct a Nature Trail 23

1. Create Trail Loops..... 23

2. Traverse Through a Variety of Habitats 24

3. Use Interpretive Materials 24

B. Establish an Education Center 25

VI. WHC'S CORPORATE WILDLIFE HABITAT CERTIFICATION PROGRAM 26

VII. SUGGESTED IMPLEMENTATION SCHEDULE..... 27

VIII. SUMMARY 29

Table 1. Representative List of Wildlife Found at the Woodlawn Landfill.....4

Table 2. Native Trees for expanding Wooded Corridors.....17

Table 3. List of Native Grasses and Wildflowers for the Woodlawn Landfill..19

Figure 1. Rotational Mowing.....13a

Figure 2. Brush Piles.....15a

**APPENDIX A
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AR312459

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Stokes, Donald and Lilian. 1989. *The Hummingbird Book: The Complete Guide to Attracting, Identifying, and Enjoying Hummingbirds*. Little, Brown and Company, Boston, Massachusetts. 87 pp.

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AR312461

**APPENDIX B
WILDLIFE CITED**

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SPECIES LIST

Birds

American robin	<i>Turdus migratorius</i>
blue jay	<i>Cyanocitta cristata</i>
Eastern bluebird	<i>Sialia sialis</i>
European starling	<i>Sturnus vulgaris</i>
house sparrow	<i>Passer domesticus</i>
kingbird	<i>Tyrannus</i> spp.
red-tailed hawk	<i>Buteo jamaicensis</i>
rufus-throated hummingbird	<i>Archilochus colubris</i>
scarlet tanager	<i>Piranga olivacea</i>
tree swallow	<i>Tachycineta bicolor</i>
white-tailed deer	<i>Odocoileus virginianus</i>
wild turkey	<i>Meleagris gallopavo</i>
woodduck	<i>Aix sponsa</i>
wood thrush	<i>Hylocichla mustelina</i>

Mammals

cottontail rabbit	<i>Sylvilagus floridanus</i>
gray squirrel	<i>Sciurus carolinensis</i>
fox	<i>Vulpes</i> spp.
raccoon	<i>Procyon lotor</i>

Plant

bayberry	<i>Myrica</i> spp.
beard tongue	<i>Penstemon digitalis</i>
bee balm	<i>Monarda didyma</i>
bitternut hickory	<i>Quercus rubra</i>
black-eyed susan	<i>Rudbeckia Hirta</i>
blackgum	<i>Nyssa sylvatica</i>
black locust	<i>Robinia pseudoacacia</i>
blue aster	<i>Aster azureus</i>
broom sedge	<i>Andropogon virginicus</i>
butterfly weed	<i>Asclepias tuberosa</i>
Canadian hemlock	<i>Tsuga canadensis</i>
chestnut oak	<i>Quercus prinus</i>
clover	<i>Trifolium</i> spp.
columbine	<i>Aquilegia canadensis</i>
corn	<i>Zea mays</i>
daisy fleabane	<i>Erigeron annuus</i>
dense blazing star	<i>Liatris spicata</i>

AR312463

dwarf crested iris
evening primrose
highbush blueberry
jack in the pulpit
june grass
lance-leaved coreopsis
lespedeza
little bluestem
mayapple
meadow fescue
milkweed
multiflora rose
New England aster
New England blazing star
northern red cedar
phragmites
poison ivy
possumhaw viburnum
purple coneflower
purple love grass
redosier dogwood
red oak
serviceberry
shooting star
side-oats grama
smooth sumac
sorghum
spicebush
swamp sunflower
sweetgum
switchgrass
tulip poplar
white oak
wild geranium
winterberry holly

Iris cristata
Oenothera biennis
Vaccinium corymbosum
Arisaema triphyllum
Koeleria cristata
Coeropsis lanceolata
Lespedeza spp.
Andropogon scoparius
Podophyllum peltatum
Festuca elatior
Asclepias spp.
Rosa multiflora
Aster novae-angliae
Liatris borealis
Juniperus virginiana
Phragmites spp.
Toxicodendron radicans
Viburnum nudum
Enchinacea purpurea
Eragrostis spectabilis
Cornus sericea
Quercus rubra
Amelanchier arborea
Dodecatheon meadia
Bouteloua curpendula
Rhus glabra
Sorghum halepense
Lindera spp.
Helianthus ausustifolius
iquidambar styraciflua
Panicum virgatum
Liriodendron tulipifera
Quercus alba
Geranium maculatu
Ilex verticulata

APPENDIX C
INFORMATION SOURCES

AR312465

Maryland Information Sources

Government

Department of Natural Resources
Director, Wildlife Division
Josh Sandt
Tawes State Office Bldg.
Annapolis, MD 21401
(410) 974-3195

U.S. Fish and Wildlife Service
BayScapes
Britt Eckhardt Slattery
177 Admiral Cochrane Dr.
Annapolis, MD 21401
(410) 573-4581

Environmental Contacts

The North American Bluebird
Society
P.O. Box 6295
Silver Spring, MD 20906-0295
(301) 384-2798

Wildlife Society
President
Marilyn Mause
228 Candy Tuff Dr.
Reisterstown, MD 21136
(301) 833-7990

Nurseries

Bel Air Farm Supply (annuals &
perennials)
424 N Main Street
Bel Air, MD 21014
(410) 8386111

Evergreen Farm
4219 Webster Rd.
Havre De Grace, MD 21078
(410) 9390659

Rake's Nursery
6 Barnes Corner Rd.
Colora, MD 21917
(410) 658-3015

APPENDIX D
CERTIFICATION INFORMATION

AR312467



WILDLIFE HABITAT COUNCIL™

DEMYSTIFYING WHC'S CERTIFICATION PROGRAM

A STEP-BY-STEP GUIDE

The Proud. The Elite, The WHC Certified.

What certification is and why it's good to get.

WHC's Corporate Wildlife Habitat Certification/International Accreditation Program formally validates wildlife habitat management and environmental education programs at corporate sites. In the short term, an accredited site receives credibility, distinction, media coverage, and other benefits discussed below. But in the long run, two important goals are achieved: assurance that wildlife at corporate sites will benefit from a good habitat enhancement program, and a demonstration to the public that industry and wildlife can indeed coexist.

The program has grown tremendously since its inception in 1990, from 18 certified sites to 137, resulting in a dramatic rise in WHC-recognized wildlife acreage (Chart A). In 1990, the program was attractive only to WHC members. Today, nonmember corporations from around the world are requesting applications. In addition to providing recognition, the program also serves as an incentive to develop habitat projects. And as the program expands, it also evolves. WHC continues to streamline the program while at the same time maintain its standards and respond to new opportunities, such as recognizing off-site programs.

Also, as a result of feedback and the increased international interest in the program, WHC added "international accreditation" to the title, a more broadly recognized term of achievement.

The benefits of being certified are many, with third-party validation being one of the most important to the site, and long-term management for wildlife being one of the most

important to the non-humans. Other benefits include a listing in WHC's *International Registry of Certified Corporate Wildlife Habitats*, a certificate acknowledging the site's accomplishments given at an awards banquet during WHC's Annual Symposium, and eligibility for the "Rookie of the Year" award for outstanding performance in the initial stages of a wildlife program, or "Corporate Habitat of the Year" for recertified sites. In addition, sites often receive positive media attention, a refreshing occurrence given the tendency of some media to give industry the opposite kind of coverage. Sites also qualify to display the WHC certification sign as a marker for all who pass by to note, "Now here is a corporate site that cares about wildlife!"

What's Being Demystified?

This article outlines how corporate sites with habitat projects apply for certification. What are the requirements? How should the application form itself be approached? What are the possible outcomes after application review? And finally, what is *recertification*?

The Requirements

The basic, overall standards. Everybody meets them. There're no slackers here.

Let's just get to the point. Achieving WHC accreditation is not easy. The criteria that projects must meet were established to ensure the program's credibility among professionals, the community, and the media, and its continuing value to the participants now and in the future. The requirements under a certification program that links two historically contrasting concepts, industrial production and wildlife habitat, must be strict.

Each eligible wildlife program must meet the following standards. The site must have:

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- active, sustained habitat management projects that provide benefits to native wildlife, add to the wildlife diversity of the area, and, if applicable, exceed any regulatory requirements;
- an active monitoring program that documents the habitat projects or accomplishments over time; and
- active involvement by corporate employees in the planning, implementation, and/or monitoring of the program.

The Survey

Why we did it. How we're implementing your suggestions.

Over the past five years, participants in the Certification Program have shared their ideas and concerns about the program and we've listened. Also, the Program Advisory Committee, a committee of the WHC Board of Directors, decided to make some changes to the program and wanted to hear how participants felt about these changes. So we asked for your reactions. More than 41% responded, and all had very helpful suggestions.

After compiling the preliminary results of the survey, we learned that 71% of respondents thought the standards of the Certification Program are adequate and appropriate (Chart B). Other survey questions revealed that participants view the program as credible among peers, as being valuable as a public relations tool, and as having outstanding value to the corporation (Chart C).

As a result of the survey, WHC has implemented some changes, including:

- a description of the three possible ratings after an application is reviewed by the committee;
- a shorter, more concise recertification application form; and
- separate forms for certification and recertification.

One suggestion under consideration is a school certification program that is separate from the existing Corporate Wildlife Habitat Certification Program.

Certification

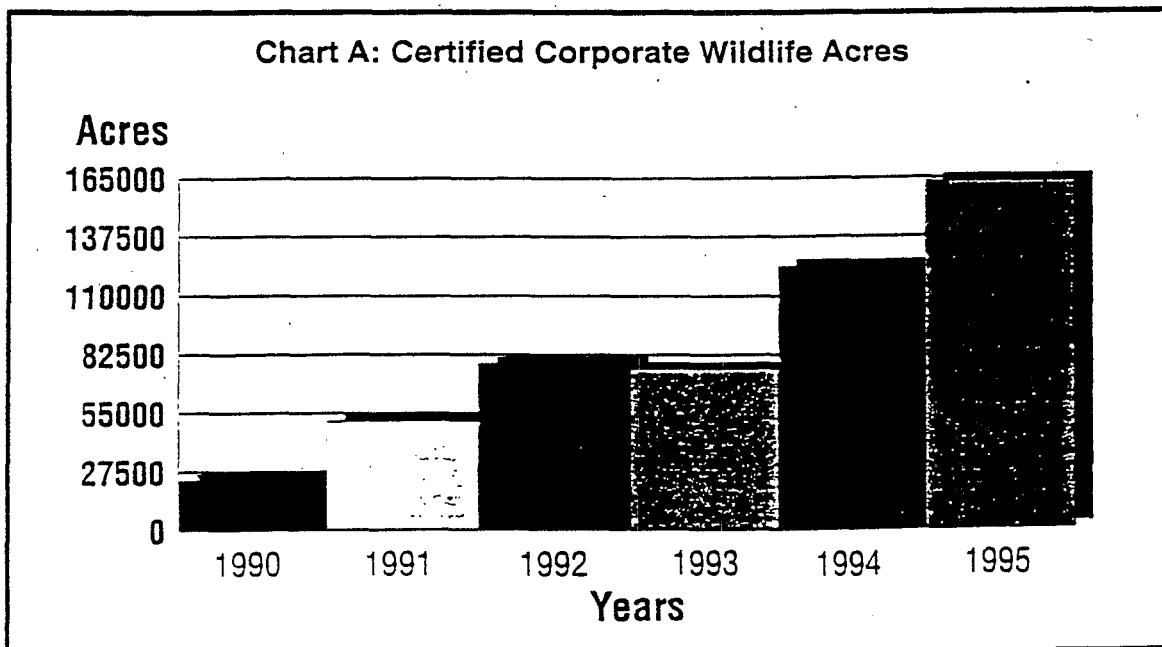
Now for the meat and potatoes. What you need to do.

The following criteria ensure that only those sites with sound, committed wildlife programs are accredited. The site must implement, maintain, and monitor at least one complete, viable habitat management project* for at least one year prior to the application deadline; create, manage, and update a site-specific wildlife management plan; provide adequate documentation (photo and written) of management efforts; been visited and formally evaluated by a WHC biologist; and demonstrate a level of commitment that will carry the program for at least two years.

* If related to mitigation or similar regulatory issue, the project(s) must exceed regulations.

Application packages must be complete and include all the information listed on the form; all information requested by WHC is necessary to process and review applications.

Chart A: Certified Corporate Wildlife Acres



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The Review Process

What's it gonna be? One of three possibilities.

Once WHC receives an application, it is checked for completeness and reviewed by the Review Committee, a team of seven WHC wildlife biologists. Each application is critically reviewed and given one of three designations: Certified, Good Start, or Denied.

◆ **Certified.** Certification is awarded to those sites that meet all of the requirements and standards of the program. Up to five outstanding newly accredited sites may be sent forward for consideration for the "Rookie of the Year" award. One site will be chosen for this award by a panel of independent judges from industry and the conservation community. (Criteria and additional information on the award are available from WHC.)

◆ **Good Start.** The primary reason for a site receiving a "good start" rather than certification is maturity: sites whose programs are less than a year old and simply have not had time to demonstrate commitment and achieve results. Applications from sites that have an active wildlife program, but do not meet all of the requirements, are placed in the good start category. Their applications (and application fee) are put on hold for one year. During the following year, WHC is able to work closely with the site wildlife team to address the components of the application that did not meet requirements. The site can submit additional documentation by the application deadline the following year in a second attempt to achieve accreditation.

◆ **Denied Certification.** Some applications are denied certification, in some cases because the project did not relate directly to habitat enhancement. Sites that are denied are invited to take advantage of WHC's assistance to develop a program that meets the standards of accreditation and maximizes its value to wildlife, employees, and the community.

Recertification

The reward for keeping up the good work.

Certified sites must submit project updates on two-year intervals, along with full descriptions of new projects, if any, that have been initiated in the last two years. This process, called recertification, ensures that only active, committed wildlife programs maintain the designation of accreditation. Pending approval by the WHC Board of

Directors, a three-year recertification rotation may be implemented beginning in 1997.

In addition to receiving continued distinction for being part of an elite group of corporate sites, one of the 82 eligible for recertification this year will receive the coveted "Corporate Habitat of the Year" award. The 1995 winner, DuPont Company-Victoria Plant in Victoria, Texas, developed a formal wildlife management plan that is supported by a vision, overall goals, key objectives, and habitat prescriptions for each area included within the plan. (Criteria and additional information on the award are available from WHC.)

As a result of the helpful suggestions received from the survey, we will supplement the original applications on file for sites applying for recertification with the additional documentation sent this year, thus reducing the amount of paper that needs to be submitted. The new recertification application form lists only those items needed for the Review Committee to review the applications, therefore, **please read the form carefully, and enclose everything that is requested.** Boxes appear by each item to help applicants check off items as they are completed.

All applications are reviewed, discussed, and ruled upon by the Review Committee. Applicants will be notified mid-September 1996. The potential outcomes after application review are:

◆ **Recertified** - awarded to sites that have successfully maintained and monitored at least one viable, accepted habitat management project, and provided adequate documentation to support the efforts of employees on site.

◆ **Restructure** - given to member sites that do not provide documentation showing that they have adequately maintained or monitored any habitat management projects. The applications are held for one year to allow the site to work with WHC to resume maintenance and monitoring of projects.

◆ **Delisted** - Given to previously accredited sites that have discontinued projects with no intent to restart them. Also given to sites in restructuring that have not resumed their management efforts.

We hope this special section has been a helpful guide through the certification or recertification processes. And remember, we are always ready to help. Just give us a call, 301/588-3994.

From "Demystifying WHC's Certification Program." Wildlife Habitat (Spring, 1996): 5-8.

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WILDLIFE HABITAT COUNCIL™

Choosing the Nominees for WHC's Rookie and Corporate Habitat of the Year Site Programs Eligible for the Three Year Recertification Rotation

This scoring sheet does not determine if a site wildlife program achieves certification, it ranks those programs achieving certification and recertification for the awards and for the three year recertification rotation. Nominees for WHC's Rookie and Corporate Habitat of the Year Awards are chosen from the pool of successful certification and recertification applications. Each site wildlife program achieving WHC certification, regardless of size of the site or number of employees, is rated on the following criteria and is eligible for these awards. The three highest ranking programs applying for initial certification are nominated for the Rookie of the Year Award. The three highest ranking programs applying for recertification are chosen as nominees for the Corporate Habitat of the Year. The previous year's winner of the Corporate Habitat of the Year is automatically nominated for the award again to give that site wildlife program a chance to retain their title. Those site programs applying for recertification that rate 21 and higher on the following criteria move into the three year recertification rotation.

(5 as best)

- 1 2 3 4 5 **Improvements to Habitat:** The habitat projects and accompanying management plan demonstrate an understanding of the interrelationship between habitat components that provide each animal's living requirements. The program lends a sense of overall conservation and is not simply a group of unrelated habitat projects.
- 1 2 3 4 5 **Scope of Projects:** Relative to the size of the site and the number of habitat types present, the program addresses or plans to address each available area at the site and strives to manage as wide a range of habitats as possible. Also, efforts to raise environmental awareness have been developed.
- 1 2 3 4 5 **Level of Commitment:** Documentation supports that monitoring and maintenance activities are done frequently and thoroughly.
- 1 2 3 4 5 **Outside Group Involvement:** The program is accessible to the local community, conservation organizations, and regulatory agencies. The wildlife program has invited outside groups to participate.
- 1 2 3 4 5 **Length of Involvement:** (*Not a criteria for Rookie of the Year*) The program is committed to implementing and monitoring a program for the long term, and outlines how this has been and will be accomplished.
- 1 2 3 4 5 **Employee Involvement:** The program involves a high percentage of employees, as well as employees from a range of levels within the company (relative to the number of employees at the site).
- 1 2 3 4 5 **Credibility:** Does the site program demonstrate that efforts are credible and provide real values to wildlife and to biodiversity and would those efforts stand up to scrutiny of other environmental professionals?

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Environmental Education Program Guidelines

Environmental education programs link wildlife habitats with the community. Educational outings provide opportunities for children and adults to learn about the natural world and ways to protect it. Programs can be created both on corporate lands and on school properties. By forming a partnership with a nature center, local school, or other community organization, corporations are able to educate individuals from a variety of backgrounds, enabling them to make a difference today and in the future.

WHC has found that the most successful programs are ongoing and involve more than funding on behalf of the company. Employees, their families, and other community members benefit from creative environmental education programs based on wildlife habitat projects.

Components of Successful Programs

- Programs focus on natural communities, inter-relationships, and the positive role that humans can play in these communities.
- Hands-on, critical thinking, and decision making activities are emphasized.
- Employees participating in the education programs attend training seminars and workshops at local nature centers, local schools or colleges, natural resource agencies, or conservation organizations. Examples include Project Wild, Project Learning Tree, and Save our Streams.

Many opportunities are available for developing environmental education programs. WHC encourages creative programs and can visit sites and meet with company and community representatives to develop appropriate environmental education programs which maximize the site's wildlife and human resources.

Examples of Programs

WHC encourages sites to consider the potential available to them to develop programs, either on their lands or on school grounds, which utilize the habitats as "outdoor classrooms." WHC members have successfully engaged in the following types of environmental education programs.

Biological Field Study Programs

- Involve numerous groups of students who par-

ticipate in standard programs.

- Incorporate projects such as Save Our Streams to capture and observe aquatic life and test water quality.
- Provide resources such as microscopes, binoculars, and animal specimens to broaden student understanding.
- Develop specific curricula, with input from teachers and students, based on habitats and species on site.

Mentoring Programs

- Involve one class and a regular group of employees with each visit building upon the knowledge gained in previous visits.
- Pair site employees with unique groups of students, such as those "at risk."
- Emphasize the development of one-on-one relationships which foster an appreciation and sense of respect for nature and provide role models.
- Emphasize cooperative activities such as studying prairie plots, constructing nature trail markers, monitoring nesting structures, conducting ongoing species inventories, and planting trees to create wildlife corridors.
- Develop specific curricula, with input from teachers and students, based on habitats and species on site.
- Document changes in attitudes with written comments from employees and students.

Nature Trails

- Provide public access.
- Offer naturalist-guided walks, self-guided written brochures, interpretive signage, or a combina-



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Wildlife Management Plan Guidelines

Regardless of how large your program is, or how extensive your plans, you will want to establish a working management plan. The plan outlines your goals, defines your programs, and offers guidelines to insure that the achievements you have made in habitat enhancement are maintained and continue to benefit wildlife.

Writing out your wildlife management plan also details your enhancement program and provides the beginnings of WHC's Wildlife Habitat Certification application process. Remember as you develop your plan that it should become a working document. It is intended to be modified as goals change due to conditions and in response to the implementation of your projects. A sample management plan is available.

Format

To be successful, your management plan should include the following six sections.

1. Introduction

Begin with an overview of your program. Describe the basic elements, how your company became involved in habitat enhancement projects, and the overall goals of the company. Your initial goal was to form an employee wildlife committee, which can now work together to develop your wildlife management goals. A few achievable targets will encourage you to focus your efforts on specific projects. You may also want to center your goals around one specific area of your site.

2. Site Description

If you have walked on your site, this section should come easily. Identify your geographic location and proximity to nearby cities, and then provide details on the site. Establish the percentage of the site devoted to habitat, proximity of operations to the areas, and acreage. Include a map or aerial photograph of your property if available.

Once the general information has been outlined, you identify habitat types, plant species, ponds, wetlands, and special features such as cliffs and brush. It is also appropriate to describe surrounding land and adjacent property. You may also want to address former land uses. It's helpful to measure the success of your program, if you can identify, for example, a formerly mowed lawn now restored to natural prairie.

3. Wildlife Inventory and Photo References

Include your inventory information. Knowing which species occur on your site is the baseline for measuring your program's success. As reviewed in WHC's inventory guidelines, this is an ongoing project — as new species are identified, they should be added to the list. Include any plans you have for activities that will review and expand the inventory.

In addition to your inventory list, it is helpful to document your successes with photographs. Set up permanent sites where pictures can be taken periodically to document changes resulting from implementing the projects in your management plan. "Before" pictures should be taken, and follow-up photos should be taken on a regular schedule. You may want your "after" photos taken during the same time the following year. Seasonal changes will influence the appearance of the project and this allows a fair comparison to assess the progress of your projects.

4. Objectives and Prescriptions

This section provides the key to creating a working document. First, let's define the difference between the goals outlined in the introduction and the objectives and prescriptions you will develop.

Goals are designed to provide a general target for management.

Example: The goal of our management program is to enhance the present habitat conditions for the Eastern bluebird.

Objectives define what will be accomplished — How much, how many, when?

Example: Replace 51 acres of lawn with native wildflower meadow by 1996.

Prescriptions are the management methods to be implemented to accomplish the objectives — How, when, where?



WILDLIFE HABITAT COUNCIL™

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The Corporate Habitat of the Year and Rookie of the Year Awards Criteria



WILDLIFE HABITAT COUNCIL™
Corporate Wildlife Habitat Certification Program

The Corporate Habitat of the Year and Rookie of the Year awards are designed to recognize two corporate sites for outstanding environmental stewardship and voluntary employee efforts. The candidates for the awards are generated from the pool of applicants for certification and recertification. Each candidate is nominated by the WHC Certification Review Committee, and the nominees' applications are submitted to a panel of independent professional judges for review and decision. Nominees and winners are chosen based on the following criteria.

Eligibility

Corporate Habitat of the Year - Only sites that have been previously certified with programs in place for at least two years and are currently applying for recertification are considered for this award.

Rookie of the Year - Only those sites that are applying for first time certification are eligible for this award.

Requirements and Selection Criteria

Improvements to Habitat - The habitat enhancement measures are designed to improve or protect biodiversity. The management plan demonstrates an understanding of habitat needs of target species and the interrelationship of habitat components that provide the animals' living requirements.

Scope of Projects - The program should include a wide range of projects, including a diversity of habitat or species involved in the management program relative to the size of the site. The plan should also address issues beyond habitat enhancement such as environmental education, which includes developing environmental awareness among employees and the community.

Level of Commitment - The wildlife team should be highly committed, demonstrated by the contribution of time, effort, and resources relative to the size of the site. Commitment reflected in the frequency and thoroughness of maintaining and documenting the management program is considered in addition to the type and scope of the project implemented. This will be demonstrated in the activities journal and other program documentation. The extent of future plans for the management program will also be considered. For example, the application indicates changes to habitat (i.e., 400 trees planted) or an increase in species diversity indicated through inventorying and monitoring programs.

Outside Group Involvement - The enhancement program should be accessible to the local community conservation organizations, or state and federal agencies. This can occur through actively involving outside groups in on-site projects, seeking expert technical advice, and/or conducting public tours. (*It does not include hiring an outside consultant to design the program.*)

Length of Involvement - The Review Committee will examine the program based on how long it has been maintained with or before involvement of the Council, and/or how long it will take to implement and achieve the program's stated goal.

Employee Involvement - The program should involve a high percentage of employees from different levels within the company (e.g., hourly, assembly line, and managerial).

Credibility - The program should stand up to scrutiny by members of the environmental profession and provide a model for other companies.



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Wildlife Habitat Council

Wildlife Management Plan Sample

WILDLIFE MANAGEMENT PLAN

for

WOODRITE CORPORATION

Spoonville, USA

Prepared by:
Woodrite Corporation Employee Wildlife Team
in cooperation with
Wildlife Habitat Council
Local Conservation Group, and
State Department of Wildlife Conservation

January 1, 1993

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I. INTRODUCTION

Woodrite Corporation, the world's leading manufacturer of wooden spoons, is located in Spoonville, USA. After becoming incorporated in 1962, Woodrite purchased a 150 acre clear-cut lot in Spoonville, and built a production area encompassing 55 acres. The remaining 95 acres have been left to natural succession, and some of the 320 employees have been interested in forming nature trails and benefiting the wildlife on the property. The extent of present habitat enhancement structures on Woodrite's property is limited to a bird feeder and birdbath in a courtyard area near Mirror Pond.

At the request of various employees, the plant manager contacted the Wildlife Habitat Council (WHC) in May 1992 to obtain assistance in developing a wildlife management program for the company property. A site visit by a WHC biologist was conducted in September 1992, and management opportunities for the 95 acres available for enhancement were discussed, outlined, and compiled by November 1992. An organizational meeting for establishing a wildlife team was held, resulting in 11 team members.

The resulting wildlife management plan was compiled by the wildlife team based on recommendations from WHC and the State Department of Wildlife Conservation. Over time, the plan is designed to increase biodiversity on the property by implementing enhancement projects and linking existing habitats with adjoining habitats to provide a stable, more diverse ecosystem.

To work toward an increase in biodiversity, the plan includes one, three, and five year goals. During the first year, the team will focus on protecting and enhancing the Mirror Lake area. In addition to maintaining the original projects, the three-year goal includes plans to improve habitat for bluebirds and purple martins and create butterfly gardens and wildflower meadows. In five years, the team hopes to build upon the success of the initial projects to develop and implement a forest management program for the 75 acre woodlot and pursue an agreement with the neighboring farmer to improve the quality of his pasture for both wildlife and his cattle. Specific objectives and prescriptions for the first-year goals are provided later in this plan.

II. SITE DESCRIPTION

When the Woodrite Corporation purchased the land for its corporate headquarters in 1962, the property was in the early successional stages of growth following a clear-cut. Now, 31 years later, an even-aged stand of pole-sized American beech and sugar maple covers about 75 acres to the north of the office and production complex.

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The site is bordered on the north and south by residential areas, and on the east by a town park consisting of mowed lawns with an abundance of large silver and sugar maples. The western portion of the property is adjacent to land owned by a farmer and used as a pasture for cattle. This pasture and streambank have been overgrazed, and the resulting vegetation is in poor condition.

Mirror Lake, a 4 acre pond, separates the forested area from the production area, and is stocked with largemouth bass and brown bullhead. The area immediately surrounding the pond is mowed lawn. The pond inlet, Moss Creek, empties into the east side of the lake. Improper forest management techniques have been applied along the shores of the Moss Creek upstream of the lake, resulting in a high amount of sediment washing into the creek, and thus poor lake water quality. The outlet flows from the west side of Mirror Lake. For a map of Mirror Lake, see *Figure 1*.

The office and production area consists of approximately 25 acres of mowed lawn, half of which is a large flat lawn on both sides of the entrance road.

III. SITE INVENTORY AND PHOTO REFERENCE STATIONS

One of the first steps in managing the property was to conduct a site inventory and establish photo reference stations. These are tools used to measure the progress of the program. An inventory of plants and animals found on the property is included in *Appendix B*. This list is a result of an inventory walk done soon after the establishment of the wildlife team on November 23, 1992. Updates to the inventory list will be made during the course of the projects and scheduled inventory walks will be held seasonally to document wildlife using the property.

Photo reference stations were set up on the first inventory walk at locations noted on the site map (see *Figure 1*). During subsequent inventory walks, pictures will be taken from these stations to document the results of the management projects.

IV. HABITAT ASSESSMENT TO DETERMINE THE PROGRAM'S GOALS

During the site inventory the wildlife team focused on identifying plant and wildlife species on the property as well as determining what habitat requirements were lacking for wildlife species present. In order for a species to occupy a particular habitat, the four basic needs of wildlife must be present: food, water, protective cover, and space for foraging and raising young. A well developed wildlife habitat management program should address all of these requirements.

The ultimate goal of any well conceived wildlife program should include the protection and enhancement of biological diversity (biodiversity). Biodiversity is a

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measure of the number of species of plants and animals, their populations, distribution, and genetic composition, in a given area or ecosystem. Ecosystems with a high degree of biodiversity are better able to withstand and recover from disturbances. The habitat assessment of the Spoonrite property determined that some habitat requirements were lacking, limiting the number of species on site.

It was determined during the site inventory/habitat assessment that there is a need for a greater diversity of plant species to provide more food and cover for wildlife. The shorelines of Mirror Lake and Moss Creek are particularly limited in the amount of vegetation available for food, cover, and good water quality. The lack of vegetation in and around Mirror Lake is limiting the amount of food, cover, and spawning habitat for fish. In order to enhance the lake for fish, the amount of aquatic vegetation should be increased and underwater structures should be added to the bottom of the lake to increase cover for the fish. Mirror Lake was also found to be lacking nesting sites for cavity nesting birds such as the wood duck. In order to attract cavity nesting birds, the habitat around the lake must be improved to provide nesting sites and a source of food. In order to improve the habitat for species that we are trying to attract, the wildlife team did some research into the life histories of those species. The research included the foods, nesting sites, and cover preferred. This research provided us with a better idea of what to focus on when we developed the goals of the wildlife program outlined in the next section.

V. GOALS, OBJECTIVES, AND PRESCRIPTIONS

The wildlife team will focus on three goals during the first year of this plan. To increase biodiversity in the Mirror Lake area, the following goals, objectives, and prescriptions will be implemented. Progress towards these goals will be documented in the activities journal, *Appendix A*.

Goal 1. Increase the abundance and diversity of plant species.

Goal 2. Provide appropriate habitat for wood duck.

Goal 3. Enhance the quality of the lake for fish.

Goal 1: Increase the abundance and diversity of plant species.

Objective: Create three peninsulas on the shoreline of Mirror Lake by fall 1993 and an island by fall 1994 to provide more cover and food resources for wildlife.

Prescriptions: 1) Dredge coves in the shoreline and use fill to create peninsulas in July 1993. Points will be depicted on the site map. A backhoe will be used. Coves will be left at the

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resulting depth, but peninsula shorelines will be sloped at a 2:1 ratio.

2) Create an island by piling rock, crushed stone, and soil at the location depicted on the site map. An excavator will be used, and the island shorelines will be left at the resulting slope. This project will begin in summer 1994.

Objective: Improve the quality of the water within the lake by fall 1994.

Prescriptions: 1) Plant the disturbed areas of the Moss Creek shoreline with a grass/forb mixture provided in *Appendix A*. Seeding will be done in March 1993 using a broadcast seeder.

2) Plant cattail, bulrush, and sedges in the areas depicted on the map in May 1993. Tubling plants will be used and planted in a random, natural pattern.

Goal 2: Provide appropriate habitat for wood duck.

Objective: Construct and erect 6 wood duck nest boxes around Mirror Lake by spring 1993 to compensate for the lack of natural nesting cavities.

Prescriptions: 1) Construct 6 wood duck nest boxes over the winter of 1992-93 using the guide provided by WHC.

2) Erect the 6 nest boxes on randomly selected trees in the forest no more than 100 feet from the shore and 10 feet high. Placement should be done in February 1993.

Objective: Enhance food sources for wood ducks by planting beech and oak trees on the forest edge, and smartweed and arrow arum on the lake shoreline by spring 1993.

Prescriptions: 1) Plant 25 oak seedlings and 25 beech seedlings around the edge of the hardwood forest to the north of the pond in May 1993.

2) Plant 50 arrow arum rhizomes randomly along the entire shore of Mirror Lake, and seed smartweed along the northern shore of the lake in May 1993.

AR312479

Goal 3: Enhance the quality of the lake for fish.

Objective: Provide bottom structures for cover, feeding, and spawning habitat throughout the lake by fall 1993.

- Prescriptions:
- 1) Place 6 brush piles consisting of loosely tied bundles of dead tree limbs between 4 and 6 feet long at locations designated on the map in August 1993.
 - 2) Place 3 piles of rocks at locations designated on the map in September 1993. Rocks should be of various sizes and placed in a pile at least two feet high and four feet across.

Objective: Provide aquatic vegetation on new and existing shore areas to increase spawning habitat, cover, and feeding areas for fish.

- Prescriptions:
- 1) Install 100 eelgrass plantings in the new shoreline areas shown on the map in May 1994.
 - 2) Plant native willow and alder upstream from the mouth of Moss Creek to reduce sedimentation on fish spawning beds.

VI. MONITORING AND MAINTENANCE

Maintenance and monitoring are crucial aspects of the management plan, and can be used to determine the success or failure of any projects. Each monitoring and maintenance action will be recorded in the wildlife team activities journal. Also, notes regarding any observations, wildlife use, and other interesting information will be recorded for future reference.

Goal 1: Increase the abundance and diversity of plant species. Monitoring includes:

- 1) Monitor the quality of the water at the inlet of the lake, in the center of the lake, and at the outlet of the lake before, during, and after the vegetation is planted on the shores of Moss Creek. Measurements and observations regarding dissolved oxygen, clarity, and temperature will be recorded in the activities journal.

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2) Monitor the success/failure of the wetland vegetation plantings by first inspecting the growth daily until the plants are established, and then weekly. Observe the plants to determine success of any one plant species over another, wildlife use, and general appearance and record these observations in the activities journal.

Goal 2: Provide appropriate habitat for wood duck. Monitoring includes:

1) Monitor the wood duck boxes in accordance with WHC's *Nest Monitoring Program*. Check for signs of predations and take steps to reduce predation if it occurs. Repair damaged boxes and clean all boxes annually.

2) Monitor the plantings around the shoreline on a weekly basis. Maintain the areas immediately surrounding the planted trees to discourage grass and shrub overgrowth. Observe and record in the activities journal success/failure of any one species, wildlife use, and possibilities for future plantings.

Goal 3: Enhance the quality of the lake for fish. Monitoring includes:

1) Monitor the eelgrass plantings weekly to determine success or failure. Observe and record in the activities journal any wildlife use and possibilities for future plantings.

VII. IMPLEMENTATION SCHEDULE

The following schedule is subject to changes due to weather and other factors. Entries that have been accomplished prior to applying for certification and any changes in the schedule are included in the activities journal. It should be noted that although it does not appear in this schedule, maintenance and monitoring is and will be done constantly, and is also being thoroughly documented in the wildlife team activities journal.

Winter 1992-1993 Inventory walk. Establish photo reference stations. Construct six wood duck boxes.

February 1993 Place wood duck boxes.

March-April 1993 Inventory walk. Prepare and seed Moss Creek shoreline.

May 1993 Plant wetland vegetation and trees around Mirror Lake.

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- July 1993 Inventory walk. Dredge coves and create peninsulas in Mirror Lake.
- August 1993 Place brush piles in Mirror Lake.
- September 1993 Inventory walk. Placement of rock piles in Mirror Lake.
- Winter 1993-1994 Inventory walk. Explore bluebird and wildflower meadow management objectives and prescriptions. Apply for WHC certification.
- May 1994 Inventory walk. Plant eelgrass in Mirror Lake.
- July 1994 Inventory walk. Create an island in Mirror Lake.
- October 1994 Inventory walk. Finalize bluebird and wildflower meadow management plan. Discuss objectives and prescriptions involved in increasing bottom depth and texture diversity.
- Winter 1994-1995 Inventory walk. Explore purple martin management and butterfly garden project opportunities.

Monitoring of existing programs will continue as previously described. New projects will be implemented as specific objectives and prescriptions are developed and human and financial resources are available.

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APPENDIX A

WOODRITE CORPORATION ACTIVITIES JOURNAL

September 13, 1992 A Wildlife Habitat Council (WHC) biologist visited to discuss opportunities available for a wildlife habitat program at Woodrite Corporation. Mirror Lake, Moss Creek, and the forest behind the lake were visited by a group consisting of the WHC biologist; Jim Herde, Spoon Quality Control; Beth Kippen, Marketing Coordinator; Tom Jacobs, Maintenance Supervisor; and James Woodrite, President.

November 5-12, 1992 The report *Opportunities for the Enhancement of Wildlife Habitat at Woodrite Corporation* arrived and was circulated and discussed by Jim Herde, Beth Kippen, and Tom Jacobs. James Woodrite contacted Jim Herde and set a date for the first wildlife team meeting for November 23, 1992 at 9:00 am at the Spoon Office. Beth Kippen would advertise by placing memos on bulletin boards in lunchroom.

November 23, 1992 The first wildlife team meeting was held. Participants were: Jim Herde, Beth Kippen, Tom Jacobs, James Woodrite, Billy Ashford, Victor Valdez, and John Weiczuk. The plan was reviewed by all, and an inventory date was set for December 19, 1992. A meeting would be held following the walk, with hot cocoa and donuts provided by Jim Herde's wife. The Wood Duck Management Series provided by WHC was copied for interested individuals.

December 5, 1992 Billy Ashford talked to the Rome High School shop teacher, who agreed to have his class build 6 wood duck nest boxes, as long as Woodrite supplied the wood.

December 19, 1992 The inventory walk was held. Mrs. Woodrite provided assistance with identifying trees and some birds. Ten bird species were seen, and photo reference stations were set up and pictures were taken around the lake at locations depicted on the map. We all learned a lot.

January 10, 1993 Tom Jacobs talked to a state forester to get suggestions for species to plant on Moss Creek shoreline. The forester would provide a list to supplement the WHC list within 3 weeks.

January 20, 1993 A team meeting was held. Billy Ashford and his son brought in the completed nest boxes, and a thank you note for the class was drafted by James Woodrite. The boxes are planned to be placed on February 7 by Billy Ashford and Jim Herde. Everyone else was invited to help as well.

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February 7, 1993 A snowstorm made placing the wood duck nest boxes impossible and dangerous. The nest boxes will be placed the following weekend, on February 14.

February 25, 1993 A team meeting was held, Tom Jacobs brought in the list supplied by the state forester for plantings on Moss Creek shoreline. The list included more tree species to be planted, and a final list was compiled so Tom could get a price estimate from Meade's Nursery, a local greenhouse. The nest boxes were finally erected after the meeting with help from all the members. A red-breasted nuthatch was seen during the walk to the site!

March 17, 1993 A team meeting was held, and a new member, Jackie Hernandez was present. The Moss Creek shoreline would not be planted in March because of the amount of snow remaining. The spring inventory was scheduled for April 5, 1993. All members were urged to attend, and the local chapter of the Audubon Society would be invited as well. Wood duck boxes were checked after the meeting by Victor Valdez and James Woodrite; none were damaged.

April 5, 1993 The spring inventory was held. The group of 11 was split into four smaller groups. A member of the Audubon Society was in each of the groups. The inventory was an incredible success, and photos were taken at the photo reference points. Three pairs of wood ducks were seen on Mirror Lake, and flock of savannah sparrows (uncommon in this area) were seen near Moss Creek. Results of the inventory were posted in the lunchroom.

April 6, 1993 The Moss Creek shoreline was seeded and trees were planted by Jackie Hernandez, Tom Jacobs, and Beth Kippen.

April 19, 1993 Three new employees were present at this meeting, and stated that excitement surrounding the successful inventory was the cause for a new interest in the program. John Weiczuk got a local nursery to donate trees for Mirror Lake plantings on condition that local students would be invited to help. Wood duck nest boxes were monitored after the meeting. Four were being used, one of which was dump nested. The Moss Creek shoreline plantings were monitored, and the uncommon flock of savannah sparrows spotted during the inventory was seen eating all of the seeds. The area must be replanted.

May 1, 1993 Wild turkeys were seen feeding and doing courtship displays on east shore of lake. All employees were talking about it at lunch. The Moss Creek shoreline was examined by Tom Jacobs and James Woodrite to determine the possibility of future replanting. Erosion is extremely bad in some areas, and James decided the best way to deal with it would be to call the state Department of Wildlife Conservation for assistance. Plantings would be postponed for the time being.

AR312484

May 15, 1993 Wetland plants and trees were planted on the Mirror Lake shoreline as planned. Thirteen members of Mr. Wiggs' 8th grade class were present to help. The plantings look a little sparse, but Mr. Wiggs, a former landscaper, said not to worry, they would fill in over time. Monitoring of wood duck nest boxes was done by Beth Kippen while planting was being done. A brief wildlife team meeting was held after the planting session.

June 23, 1993 Frogs and minnows were observed among new wetland plants in Mirror Lake. An excavator and bucket loader were scheduled to create coves and peninsulas on July 13 through the 15. A meeting was held, and an inventory walk was scheduled for July 5.

July 5, 1993 The summer inventory walk was held, 6 team members were present. A bluebird was seen sitting on the post used to mark the photo reference station. Also, an American bittern was spotted among the wetland plantings. Two separate wood duck hens with 6 ducklings each were seen in the vicinity of the lake.

July 13, 1993 The coves were dredged by Victor Valdez in the excavator, Jim Herde, and Billy Ashford. The excess soil was piled along the shore to form peninsulas. The water in the lake was quite cloudy as a result of digging, and members of the wildlife team were concerned and made plans to check it periodically along with other monitoring procedures. Also, excess seed from Moss Creek shoreline plantings was spread on the exposed peninsula soil.

July 20, 1993 A team meeting was held, and the local community was invited to tour the habitat enhancement projects done so far. Monitoring of the nest boxes was done during the tour to show participants how to check a nest box. Interest was generated, and some members stayed to construct and place 3 brush piles in Mirror Lake ahead of schedule.

August 19, 1993 A regular meeting was held. Six members were present. Beth Kippen brought to the team's attention that she found purple loosestrife, an exotic, invasive weed on a new peninsula on Mirror Lake, and that she would check with WHC and state biologists to plan a course of action.

*Note: For certification, the activities journal should be completed for all activities and meetings up to the time of certification application. Minutes from wildlife team meetings are also helpful for certification.

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Printed on Recycled Paper.

January 1995

AR312485

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Printed on Recycled Paper

February 1994

AR312486