PERMIT APPLICATION

Corrective Action Design

Hamilton Landfill Closure
Hamilton, Massachusetts

July 2013

CDM Smith

CDM Smith
50 Hampshire Street
Cambridge, Massachusetts 02139
tel: 617 452-6000
fax: 617 452-8000

July 23, 2013

Mr. John Carrigan
Section Chief – Solid Waste
Northeast Regional Office
Massachusetts Department of Environmental Protection
205B Lowell Street
Wilmington, Massachusetts 01887

Subject: Corrective Action Design
Hamilton Landfill Closure
MassDEP Transmittal Number X252969

Dear Mr. Carrigan:

On behalf of the Town of Hamilton, Massachusetts, CDM Smith Inc. (CDM Smith) submits the Corrective Action Design (CAD) for closure of the Hamilton Landfill. The CAD was developed from the conclusions presented in the CSA and CAAA, as well as in accordance with the Solid Waste Management Regulations (310 CMR 19.000) promulgated by the Massachusetts Department of Environmental Protection (MassDEP) and the Landfill Technical Guidance Manual (LTGM, 1997).

The Town of Hamilton continues to plan for construction start in the fall of 2013, so that future post-closure use plans can continue to move forward on schedule. It is anticipated that substantial completion of the landfill closure construction will be reached in spring 2014 and final completion by the end of 2014.

Please do not hesitate to call me at (617) 452-6589 or Bruce Haskell at (617) 452-6541, if you have any questions or require additional information.

Very truly yours,

Laura A. Bugay, P.E.
Project Manager
CDM Smith Inc.

Attachments

cc: Michael Lombardo, Hamilton

David Hanlon, Hamilton
Bruce Haskell, CDM Smith
File: 0644/89096/03/05

Enter your transmittal number → X252969 (Transmittal Number)

Your unique Transmittal Number can be accessed online: http://mass.gov/dep/service/online/trasmfrm.shtml

Massachusetts Department of Environmental Protection

Transmittal Form for Permit Application and Payment

1. Please type or print. A separate Transmittal Form must be completed for each permit application.

2. Make your check payable to the Commonwealth of Massachusetts and mail it with a copy of this form to: DEP, P.O. Box 4062, Boston, MA 02211.

3. Three copies of this form will be needed.

Copy 1 - the original must accompany your permit application. **Copy 2** must accompany your fee payment. **Copy 3** should be retained for your records

4. Both fee-paying and exempt applicants must mail a copy of this transmittal form to:

MassDEP
P.O. Box 4062
Boston, MA
02211

*** Note:**
For BWSC Permits, enter the LSP.

A. Permit Information

BWP SW 25	Corrective Action Design
1. Permit Code: 7 or 8 character code from permit instructions	2. Name of Permit Category

Landfill Closure
3. Type of Project or Activity

B. Applicant Information – Firm or Individual

Town of Hamilton, Massachusetts
1. Name of Firm - Or, if party needing this approval is an individual enter name below:

2. **Last Name** of Individual	3. **First Name** of Individual	4. MI

577 Bay Road
5. Street Address

Hamilton	MA	01982	978-468-5580	
6. City/Town	7. State	8. Zip Code	9. Telephone #	10. Ext. #

David Hanlon	
11. Contact Person	12. e-mail address (optional)

C. Facility, Site or Individual Requiring Approval

Hamilton Landfill
1. Name of Facility, Site Or Individual

Chebacco Road
2. Street Address

Hamilton	MA	01982		
3. City/Town	4. State	5. Zip Code	6. Telephone #	7. Ext. #

172565		
8. DEP Facility Number (if Known)	9. Federal I.D. Number (if Known)	10. BWSC Tracking # (if Known)

D. Application Prepared by (if different from Section B)*

CDM Smith Inc.
1. Name of Firm Or Individual

50 Hampshire Street
2. Address

Cambridge	MA	02139	617-452-6541	
3. City/Town	4. State	5. Zip Code	6. Telephone #	7. Ext. #

Laura Bugay, P.E.	
8. Contact Person	9. LSP Number (BWSC Permits only)

E. Permit - Project Coordination

1. Is this project subject to MEPA review? ☐ yes ☒ no
   If yes, enter the project's EOEA file number - assigned when an Environmental Notification Form is submitted to the MEPA unit:

EOEA File Number

F. Amount Due

DEP Use Only

Permit No:

Rec'd Date:

Reviewer:

Special Provisions:

1. ☒ **Fee** Exempt (city, town or municipal housing authority)(state agency if fee is $100 or less).
   There are no fee exemptions for BWSC permits, regardless of applicant status.
2. ☐ Hardship Request - payment extensions according to 310 CMR 4.04(3)(c).
3. ☐ Alternative Schedule Project (according to 310 CMR 4.05 and 4.10).
4. ☐ Homeowner (according to 310 CMR 4.02).

Check Number	Dollar Amount	Date

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention – Solid Waste Management

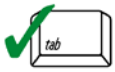
BWP SW 12 Initial Site Assessment
BWP SW 23 Comprehensive Site Assessment
BWP SW 24 Corrective Action Alternative Analysis
BWP SW 25 Corrective Action Design
Application for Landfill Assessment and Closure

X252969
Transmittal Number

172565
Facility ID# (if known)

A. BWP SW 12 Initial Site Assessment: 310 CMR 19.150(4)

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



Directions: Specify the report/plan and page numbers in which the following information is located.

	Plan/Report #	Page #	DEP Use Only
1. Initial Site Assessment (310 CMR 19.150(4))			
a. Background information	N/A	N/A	
b. Historical Research			
c. Literature/Data Search			
d. Hydrogeological Description			
e. Site Visit			
f. Mapping			
g. Field Screening			
2. Comprehensive Site Assessment Scope of Work			
3. Funding			
a. Corrective action and/or closure-post closure cost estimate			
b. Funding mechanism and schedule			

B. BWP SW 23 Comprehensive Site Assessment: 310 CMR 19.150(5)

	Plan/Report #	Page #	DEP Use Only
a. ISA Summary	N/A	N/A	
b. Mapping			
c. Drilling Program			
d. Determination of Hydraulic Conductivity			
e. Sampling and Analysis Plan			
f. Health and Safety Plan			
g. Project Schedule			

B. BWP SW 23 Comprehensive Site Assessment: 310 CMR 19.150(5) (cont.)

		Plan/Report #	Page #	DEP Use Only
h.	Baseline Risk Assessment			
i.	Corrective Action Alternative Analysis Scope of Work Outline			

C. BWP SW 24 Corrective Action Alternative Analysis: 310 CMR 19.150(6)

		Plan/Report #	Page #	DEP Use Only
a.	Corrective Action Objectives	N/A	N/A	
b.	Alternatives Analysis			
c.	Recommended Alternative			

Important Note: Engineering Plans must be stamped by a Registered Professional Engineer (PE). Property Line Location must be stamped by a Registered Land Surveyor (RLS).

D. BWP SW 25 Corrective Action Design: 310 CMR 19.151(2)(a)

		Plan/Report #	Page #	DEP Use Only
a.	Corrective Action Design and/or closure plans	Report/Plans	All	
b.	Implementation schedule	Report	Cover letter	

E. Post Closure Plans

Note: Part E is only applicable when a closure plan has been submitted and closure is being implemented.

		Plan/Report #	Page #	DEP Use Only
1.	Maintenance Plan {310 CMR 19.142(5)}	N/A	N/A	
2.	Monitoring Plan {310 CMR 19.142(5)}			
3.	Post-Closure Use Plans {310 CMR 19.143} (if applicable)			
4.	Record Notice of Landfill Operation {310 CMR 19.141}			

Massachusetts Department of Environmental Protection
Bureau of Waste Prevention – Solid Waste Management

BWP SW 12 **Initial Site Assessment**
BWP SW 23 **Comprehensive Site Assessment**
BWP SW 24 **Corrective Action Alternative Analysis**
BWP SW 25 **Corrective Action Design**
Application for Landfill Assessment and Closure

X252969
Transmittal Number

172565
Facility ID# (if known)

F. Certification & Engineer's Supervision: 310 CMR 19.011

Engineer's Supervision:

All papers pertaining to design, operation, or engineering of this site or facility shall be completed under the supervision of a Massachusetts registered professional engineer knowledgeable in solid waste facility design, construction and operation, and shall bear the seal, signature and discipline of said engineer. The soils, geology, air monitoring and groundwater sections of the application or monitoring report shall be completed by competent professionals experienced in the fields of soil science and soil engineering, geology, air monitoring and groundwater, respectively, under the supervision of a Massachusetts registered professional engineer. All mapping and surveying shall be completed by a registered surveyor.

Laura A. Bugay
Print Name

Authorized Signature

Project Manager
Position/Title

CDM Smith Inc.
Company

MA 47599
P.E. #

7/23/13
Date

Certification:

Any person, required by these regulations or any order issued by the Department, to submit papers shall identify themselves by name, profession, and relationship to the applicant and legal interest in the facility, and make the following certification: "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties both civil and criminal for submitting false information including possible fines and imprisonment."

David Hanlon
Print Name

Authorized Signature

Hamilton Deprtment of Public Works Director
Position/Title

22 July 2013
Date

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Appendices

Section 1
Introduction

1.1 Basis of Approach

This Corrective Action Design (CAD) permit application provides the design for the selected final corrective action approach developed through the Corrective Action Alternative Analysis (CAAA) for the Hamilton Landfill in Hamilton, Massachusetts. CDM Smith Inc. (CDM Smith) has prepared this report in accordance with the MassDEP's Solid Waste Management Regulations (310 CMR 19.000) and Landfill Technical Guidance Manual (LTGM, 1997). The CAAA was developed according to the information and conclusions presented in the Initial Site Assessment (ISA), dated December 1991 and prepared by CDM Smith and the Comprehensive Site Assessment (CSA), dated November 2008 and prepared by S E A Consultants, Inc. (SEA). Appendix A contains pertinent MassDEP approvals and correspondence pertaining to the landfill site and closure process as presented herein.

1.2 CAAA Summary

The CAAA evaluated options pertaining to the closure of the various areas of the Hamilton Landfill (Areas 1, 1A, 2, 2A and 2B). Options were presented for the final landfill cap over each of these areas. The selected option for each of these landfill areas are as follows:

- Area 1: Existing cap to remain with tree removal and topsoil and vegetation maintenance, as necessary.
- Area 1A: Alternative pavement cap.
- Area 2: Cap with 3-foot alternative soil cap.
- Area 2A: Cap with 3-foot alternative soil cap.
- Area 2B: Relocate waste and/or cap with 3-foot alternative soil cap.

These areas are shown on Sheet C-1 included in Appendix B.

The CAAA also addressed landfill gas and sediments at the site. Based upon the nature and age of waste present at the site and perimeter soil gas sampling data, shallow passive gas vents were proposed in the CAAA for areas where capping occurs. No corrective actions are required for the sediments in the surrounding wetlands as the CSA concluded there were no significant impacts to sediments from the landfill areas.

1.3 Site Conditions

1.3.1 Extent and Type of Waste

Area 1 of the landfill operated from the 1950's until 1978, primarily as a burn dump. Following notices of noncompliance, this landfill area was capped generally in accordance with the then current

regulatory requirements. The remainder of the landfill areas continued to receive waste for a few years until the early 1980's when operations ceased. Areas 2, 2A and 2B operated from approximately 1978 until 1983 and have evidence of being lined with clay. The landfill was only used by the Town of Hamilton, a primarily residential community.

The limit of waste was delineated by SEA as part of the CSA. Additional test pits will be conducted at the beginning of construction to finalize waste delineation on the west side of Area 2B. The edge of waste is shown on Sheet C-1 contained in the plan set attached in Appendix B.

As presented in the CAAA, most of Area 1 has already been capped with an approximate 24-inch soil cap.

1.3.2 Existing Landfill Conditions

As mentioned above, Area 1 has already been capped with an approximate 24-inch soil cap. This area and the cap are in good condition with well established vegetation. Some small trees and shrubs are present within the limits of the cap which will be removed during closure construction. Area 1A is currently being used as a Department of Public Works (DPW) operations area for residential drop-off of brush. This area, once capped, will again be used for this purpose by the Town. Areas 2, 2A and 2B are uncapped with a varying layer of intermediate cover. A skeet and trap range currently operates on Area 2A; Area 2 is vegetated with grasses and Area 2B is wooded. Wetlands exist to the north, south and east of the site. Sheet C-1, contained in Appendix B shows the existing conditions at the landfill site.

1.4 Post-Closure Use

The Town is considering multiple post-closure uses at the site. At the site entrance, the Town is proposing to retain a small DPW operations area for material storage and residential brush drop off. On Area 1, the Town is considering a solar array. Also, along the northwest edge of the property, mostly located outside the future edge of waste, the Town is proposing an anaerobic digestion facility. It is anticipated that the Skeet and Trap club will be relocated off-site and potentially the Rod and Gun Club that leases the northeastern portion of the property, located outside the landfill areas.

The proposed post-closure uses outlined above (i.e., solar array and anaerobic digestion facility) will be permitted with MassDEP with submission of an appropriate post-closure use permit application.

Section 2
Landfill Cap

2.1 Introduction

The principle function of a landfill cap is to isolate the landfilled waste materials from the environment. To accomplish this goal, the landfill cap is designed to decrease stormwater infiltration, prevent erosion of the landfill surface, provide controls for stormwater runoff, and control the migration and emission of landfill gases.

As part of construction, slopes on areas to be capped will be re-graded to 4H:1V, where feasible, with a maximum of 3H:1V and minimum of 5 percent.

This section discusses the proposed capping system for the landfill and its individual components. A detailed set of design plans is included in Attachment B.

2.2 Summary of Cap Layers

The materials selected for the layers of the cap design were chosen based upon the requirements of applicable standards and regulations as previously approved by MassDEP in the CAAA. A general description of the proposed materials is presented in the following sections. Technical specifications for the landfill closure construction, which provide a more detailed description of the required construction materials and methods, are included in Appendix C.

The following are the two types of cap cross-sections proposed for closure of the uncapped areas of the Hamilton Landfill:

- Alternative minimum 3-foot thick Soil Cap; and
- Pavement cap.

The alternative soil cap consists of a 12-inch low-permeability layer and a minimum 24-inch vegetative support layer consisting of common fill and topsoil. This cross section is presented on the detail sheet D-1, contained in Appendix B.

2.2.1 Low-Permeability Layer

The purpose of the low-permeability layer is to create an adequate barrier layer to decrease infiltration of stormwater through the waste. This layer is placed on top of the existing soil cover and/or re-graded slopes on the areas shown on the closure design plans contained in Appendix B. The material selected for use as the low-permeability layer is 12- inches of soil with a minimum hydraulic conductivity of 1×10^{-5} cm/sec.

2.2.2 Vegetative Support Layer

The vegetative cover is one of the most important elements for stability of the capping system. The vegetative cover layer must minimize erosion of the underlying soils as well as retain and promote evapo-transpiration. The vegetation's root system will not interfere with the low-permeability layers (no trees or other deep-rooted vegetation will be used) and all plant life will be capable of self-propagation. The seed mixture will contain drought-resistant seed species to quickly establish and maintain growth following construction.

The proposed vegetative support layer consists of a minimum of 24- inches of soil above the low permeability layer and is comprised of 6-inches of topsoil over 18-inches of common fill. Note that additional common fill may be added to meet proposed final grades. This layer is designed to be capable of supporting the selected vegetation. Some intermixing of the layers, approximately 2 to 3 inches between the topsoil and the common fill will occur during direct placement of topsoil over the common fill. The common fill layer will be tracked by a bulldozer during placement prior to the topsoil installation. The tracking of the common fill will allow for organics from the topsoil to intermix with the common fill layer and enhance root penetration and vegetative support.

2.2.2.1 Common Fill

The common fill used as part of the vegetative support layer will be a clean, natural soil that complies with the environmental quality standards outlined in Section 2.2.4 below. Soils shall not contain stones larger than 2-inches in diameter or fines passing the #200 sieve greater than 30 percent. The depth of the common fill layer will be a minimum of 18-inches providing a total vegetative support layer minimum depth of 24-inches. Note that to accommodate the potential future post-closure uses, the thickness of the common fill may be increased to construct a flatter plateau.

2.2.2.2 Topsoil

The topsoil portion of the vegetative support layer will either be a natural topsoil or manufactured topsoil consisting of soil and compost mix. The topsoil depth will be 6-inches with an organic content of greater than 3 percent. The depth of the topsoil layer and common fill layer combined will be a minimum of 24-inches.

2.2.2.4 Proposed Vegetative Cover

The proposed vegetation was developed specifically for vegetating and stabilizing disturbed areas on side slopes, particularly landfills. In addition, the seed mix was selected to be self-propagating and low maintenance. The vegetation is specified in the seed mix which is contained in Section 02930 of the draft technical specifications in Appendix C.

The seed mix will be applied to the topsoil by hydroseeding at an application rate of 6 pounds of seed mix per 1,000 square feet. In addition, the closure contractor will be responsible for establishing and maintaining adequate vegetation at the landfill for one year after substantial completion of the landfill cap.

All seeded slopes 4 horizontal to 1 vertical (4H:1V) or steeper will also be covered with erosion control blankets following hydroseeding. The erosion control blanket will minimize erosion and enhance moisture retention during establishment of the vegetative cover.

2.2.3 Backfill

As outlined in the specifications, soil used to backfill waste relocation areas will be a clean, natural soil that are obtained from off-site sources and shall comply with the environmental quality standards outlined in Section 2.2.4 below. Soils shall not contain stones larger than 4-inches in diameter or fines passing the #200 sieve greater than 30 percent.

2.2.4 Cap and Backfill Soil Source Control

As outlined in the specifications, all cap materials and backfill used will be a clean, natural soil that are obtained from off-site sources and shall be free of organic material, trash, snow, ice, frozen soil, solid waste, large stones, brick, concrete or other deleterious material that may be compressible or which cannot be properly compacted.

Prior to delivery of any soils, the Contractor shall provide information on the location of the proposed source and one set of test results for each source to demonstrate that the source is below standards shown in Table 2-1.

The Contractor shall provide CDM Smith with analytical testing of the proposed soil sources that includes, at a minimum, all of the parameters outlined in Table 2-1. The cap and backfill soils shall be free of any documented anthroprogenic contamination. Documentation as to the historic uses of the source site(s) and permission to allow CDM Smith to visit the source site(s) to observe project controls will be required. The Contractor shall provide laboratory analytical data for a discrete sample collected from the source site for every 500 cubic yards (measured in-place) of soils delivered for capping purposes. Note that based upon a review by CDM Smith of the results, in-situ data collected through a field investigation program may be utilized for the source testing. CDM Smith may collect additional samples at the landfill to confirm that the delivered soils are similar to the proposed source(s).

All soils delivered to the landfill for backfill or capping layers, except the topsoil, will be accompanied by a Material Shipping Record (MSR) or similar tracking document.

2.3 Landfill Cap Design Criteria

2.3.1 Hydraulic Performance

Decreasing infiltration of precipitation through the waste is the primary means of preventing leachate generation and the migration of contaminants from the waste into the groundwater. The components and design of the landfill cap system, specifically the low-permeability layer, help direct precipitation away from the waste and reduce precipitation from infiltrating through the waste mass.

The results of the CSA monitoring concluded that the landfill has minimal impacts to the environment. Based upon these conclusions, an alternative 3-foot soil cap with a 1-foot thick $1x10^{-5}$ cm/sec low-permeability layer is proposed as the final capping system. This alternative soil cap will not only provide a physical barrier, but it will provide an adequate low-permeability capping system that will reduce infiltration through the waste mass.

Table 2-1
Summary of Proposed Cap and Backfill Soil Maximum Allowable OHM Concentrations

OIL OR HAZARDOUS MATERIAL	Concentration				Maximum[1] Allowable Soil Concentration mg/kg	
	In "Natural" Soil[2] (mg/kg)	Rule-of-Thumb Multiplier	Multiplied Value (mg/kg)	RCS-1 Standard[3] (mg/kg)		
ACENAPHTHENE	0.5	10	5	4	<	4
ACENAPHTHYLENE	0.5	10	5	1	<	1
ALUMINUM	10,000	2.5	25000	NS	<	25000
ANTHRACENE	1	10	10	1000	<	10
ANTIMONY	1	10	10	20	<	10
ARSENIC	20	7.5	150	20	<	20
BARIUM	50	7.5	375	1000	<	375
BENZO(a)ANTHRACENE	2	10	20	7	<	7
BENZO(a)PYRENE	2	10	20	2	<	2
BENZO(b)FLUORANTHENE	2	10	20	7	<	7
BENZO(g,h,i)PERYLENE	1	10	10	1000	<	10
BENZO(k)FLUORANTHENE	1	10	10	70	<	10
BERYLLIUM	0.4	10	4	100	<	4
CADMIUM	2	10	20	2	<	2
CHROMIUM (TOTAL)	30	7.5	225	30	<	30
CHROMIUM(III)	30	7.5	225	1000	<	225
CHROMIUM(VI)	30	7.5	225	30	<	30
CHRYSENE	2	10	20	70	<	20
COBALT	4	10	40	NS	<	40
COPPER	40	7.5	300	NS	<	300
DIBENZO(a,h)ANTHRACENE	0.5	10	5	0.7	<	0.7
FLUORANTHENE	4	10	40	1000	<	40
FLUORENE	1	10	10	1000	<	10
INDENO(1,2,3-cd)PYRENE	1	10	10	7	<	7
IRON	20,000	2.5	50000	NS	<	50000
LEAD	100	5	500	300	<	300
MAGNESIUM	5,000	2.5	12500	NS	<	12500
MANGANESE	300	5	1500	NS	<	1500
MERCURY	0.3	10	3	20	<	3
METHYLNAPHTHALENE, 2-	0.5	10	5	0.7	<	0.7
NAPHTHALENE	0.5	10	5	4	<	4
NICKEL	20	7.5	150	20	<	20
PHENANTHRENE	3	10	30	10	<	10
PYRENE	4	10	40	1000	<	40
SELENIUM	0.5	10	5	400	<	5
SILVER	0.6	10	6	100	<	6
THALLIUM	0.6	10	6	8	<	6
VANADIUM	30	7.5	225	600	<	225
ZINC	100	5	500	2500	<	500

Source: Table 2 for maximum allowable concentrations of OHM in soil for re-use assuming Natural Background Conditions at an RCS-1 Receiving Location, "Draft Technical Update – Identifying When Soil Concentrations at a Receiving Location Are "Not Significantly Lower" than Managed Soil," prepared by MassDEP, dated March 26, 2013.

[1] Concentration of OHM in capping soil must be less than (not equal or greater than) this value.
[2] Concentrations from MassDEP document "Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil" dated May 2002.
[3] RCS-1 standards are based on current promulgated version of Massachusetts Contingency Plan (MCP; 310 CMR 40.000).
NS: No Standard

2.3.2 Side-Slope Stability

Since a flexible membrane liner (FML) geomembrane is not specified as part of the proposed capping system, a typical slope stability analysis was not conducted to calculate the structural integrity between the soil and geomembrane. Additionally, based upon the proposed maximum slopes, it is anticipated that the soil layer interfaces will have sufficient friction and not create a slip plane and ultimate failure of the side slope. Based upon these two design factors, no slope stability calculations are necessary.

2.3.3 Estimated Landfill Settlement

2.3.3.1 Anticipated Settlement

There are three major factors involved in landfill settlement; all are time dependant. Mechanical/primary compression occurs rapidly and is typically complete within approximately one month from the time filling is complete. Areas 2, 2A and 2B operated from 1977 to 1983, accepting municipal solid waste. A layer of cover soils was installed following final waste disposal and the site has remained dormant since then. Therefore, the mechanical/primary compression settlement of waste areas to be capped occurred almost 30 years ago, immediately following the end of waste disposal. CDM Smith proposes to perform some limited waste excavation and relocation as part of the corrective action. The relocated waste shall be placed within the limits of the landfill in shallow lifts with the application of a minimum of 6-inches of daily cover in accordance with MassDEP regulations. The small volume of relocated waste will not have any significant additional settlement.

Biodegradation is the primary mechanism for landfill settlement. MSW has not be been disposed of at the landfill since 1983, therefore biodegradation of the organic matter is nearing the end of its life cycle. Continued settlement due to biodegradation is likely to be minor.

Physical creep compression is caused by biodegradation from the sifting of finer materials into the voids between larger particles. Since the landfill has been dormant for over 30 years, biodegradation rates area greatly reduced, therefore the physical creep compression which only equals about 2 percent of the fill height, has primary occurred is no longer a consideration for settlement at the site.

Waste from Area 2B will be consolidated onto Area 2. Since waste from Area 2B is anticipated to be equally degraded, settlement on Area 2 due to biodegradation is expected to be minimal. Some long-term physical creep compression is still possible due to the additional relocated soil/waste mass above the existing waste due to waste consolidation. However, this settlement is small, about 2-percent; adequate compaction during waste consolidation and use of daily cover soils will aid in minimizing this type of settlement, as well as the minimal amount of additional waste to be consolidated over this area.

Based on the various models for estimating short-term and long-term settlement, any additional settlement will be minor. Further estimation and compensation for settlement of the landfill areas is unwarranted.

2.3.4 Soil Loss

Soil loss is calculated to assess the long-term integrity of the landfill cap. The Universal Soil Loss Equation, developed by the USDA was used to calculate soil loss at the site. The calculation demonstrated that soil loss at the site will be less than 2.0 tons/acre/year under a good stand of grass

and that an erosion control blanket with a C value no greater than 0.03 should be used to provide temporary erosion control prior to the establishment of vegetation. This calculation is included in Appendix D. The primary design factors that affect the loss of soil are the slope, length of slope, surface condition, and soil texture.

Soil loss is reduced with the establishment of good vegetation. The vegetative support layer soil and seed mix design is important to provide appropriate vegetation for the landfill slopes that will flourish under those conditions. Vegetation will shield the bare soils from the impact of falling precipitation as well as, bind the soil with their roots, to reduce erosion gullies on the slope.

Soil loss is also reduced by designing shorter slopes. With a typical landfill, slopes are typically not short, therefore stormwater benches/swales are constructed to break up the flow on the slopes and divert the flow off the cap. Based on soil loss calculations, and the 4H:1V slopes, no mid-slope swales are necessary.

2.4 Waste Relocation

2.4.1 Excavation and Consolidation

As an alternative to capping, waste relocation will occur in two areas of the landfill site: the northern toe of slope on Area 2 and the majority portion of Area 2B.

Waste will be relocated from the northern toe of slope along Area 2 in order to install the cap outside of the delineated edge of wetlands. Although previous test pitting activities have delineated the edge of waste as outside the wetland, waste is within close proximity to the wetland line, therefore some limited excavation within the wetlands may be necessary. If excavation is required within the wetlands limits, the wetland will be restored with appropriate soils and seed/plantings to the original wetland limits. This work shall be permitted by the Hamilton Conservation Commission through the Notice of Intent process and by way of an Order of Conditions.

Waste within a portion of Area 2B will also be relocated in preparation for potential post-closure use. Based upon test pit logs, waste was determined to be shallow in this area, therefore it is cost effective to excavate the waste and consolidate onto the Area 2 mound. Waste will be excavated to limits set by visual observation then confirmed with a sampling program. Confirmatory samples will be collected from the bottom and sidewalls of the excavation at a frequency of 4 and 6 per acre, respectively. Each composite confirmatory sample will be comprised of 4 individual grab samples from the sampling area. Additional excavation and subsequent sampling will be conducted until sample results are below the applicable Massachusetts Contingency Plan (MCP), Method 1, S-1 standards. Samples will be analyzed for and compared to the parameters and standards indicated in the table below:

Table 2-2
Confirmatory Sampling

Parameter	Test Method	Allowable Concentration	Maximum Detection limit
RCRA 8 Metals	MCP 6000 series	Below Method 1, S-1 standards	½ of MCP S-1 Standard
PAHs w/target	MCP-EPH -Deluxe	Below Method 1, S-1 standards	½ of MCP S-1 Standard

Following analytical confirmation of final excavation limits, the excavated areas will be backfilled with clean soils, as described in Section 2.2.3 and 2.2.4 above.

Excavated waste from these two areas will be consolidated onto Area 2 in maximum 18-inch lifts and compacted with a minimum 4 passes of a track dozer to achieve an approximate 90 to 95-percent compaction rate to minimize the potential for settlement. All relocated waste will be covered daily with a minimum 6-inch thick soil layer (daily cover). If bulkier waste is encountered, additional measures will be implemented to achieve adequate compaction and minimize the potential for settlement.

Section 3
Stormwater Management and Erosion Control

3.1 Introduction

Stormwater management controls were considered for the site, however due to the nature of the soil cap, the short slopes, and the existing stormwater patterns at the site, minimal controls are required. Stormwater runoff from the proposed pavement cap areas will be treated through a system of Best Management Practices (BMPs). Any future post closure use that will require stormwater controls will include additional and modify existing control measures as part of the post-closure use design and permit application.

The proposed closure design, through grading of the site will achieve the following:

- Maintain the integrity of the landfill by preventing erosion of the cap;
- Decrease the quantity of leachate production by diverting stormwater runoff away from the landfill surface and preventing ponding;
- Minimize the transport of contaminants, either in suspension or solution, from the landfill into adjacent wetland areas or groundwater receptors; and
- Maintain post-closure, off-site runoff flow rates that are less than or equal to the existing off-site flow rates.

At this site, landfill cap integrity will be maintained by the vegetative support layer discussed in Section 2, along with 4H:1V final grades that are designed to shed stormwater runoff off the cap. The proposed closure grading plan design is shown on Sheet C-3, contained in Appendix B.

The surface water runoff from Area 1 flows off the existing cap towards downgradient wetlands on the south and east sides and towards adjacent landfill areas (Areas 1A and 2B) to the west and north. As this area is already capped, no changes to stormwater controls are proposed. No drainage swales or basins were constructed as part of the previous closure of Area 1. The gradual slopes, soil cap, and short overall height of Area 1 made any mid-slope diversion drainage swales unnecessary for the cap stability or soil loss prevention. The surface water runoff from Area 2, to be capped, currently flows off the mound towards wetlands to the north and northeast, the existing access road to the south and southeast, and landfill Area 2B to the west. No modifications to the existing stormwater flow pathways will be designed for Area 2, in order to maintain the existing stormwater flow to the adjacent wetland. Because Areas 2A and 2B are small and relatively flat, no stormwater controls are necessary for these areas. Stormwater from Area 1A flows north to the northern wetland system. Since this area will be capped with an alternative pavement cap, such that the Town can maintain their DPW operations area, stormwater from the pavement cap will be routed and treated by a proposed stormwater infiltration basin after being routed through a stone level spreader, vegetated filter strip, and grass lined water quality swale.

3.2 Best Management Practices (BMPs) Implementation Program

A stormwater BMP is defined as any program, technology, process, siting criteria, operating method, measure, or device that controls, removes, or reduces pollution conveyed as runoff. Appropriate BMPs are selected based on an assessment of the operations and potential stormwater impacts. Areas of actual or potential pollutant contact are evaluated and applicable BMPs are implemented to minimize or eliminate the release and transport of pollutants to downgradient receiving waters.

To minimize the potential negative impacts on the surrounding wetlands and waterways associated with landfill closure construction activities, the initial site preparation will include the implementation of several BMPs. A discussion of the specific BMPs to be used at the site is provided in the sections below.

3.2.1 BMP Design during Construction

The anticipated sedimentation and stabilization control BMPs to be implemented during excavation, relocation, grading of materials and cap construction will include, but are not necessarily limited to, the following:

- Dust Controls;
- Erosion Control Blankets;
- Installation of temporary stormwater control structures;
- Installation of Erosion Control Barriers (Silt Fence and haybales).

Erosion and sedimentation controls will be established prior to the contractor commencing site preparation activities. Erosion control barriers will be installed surrounding the entire site and will be considered the limit of work. Installation of the erosion control barriers will be in accordance with the details, specifications and the Order of Conditions to be issued by the Hamilton Conservation Commission.

General controls, such as hay bales, will be installed at the edge of all wetland areas to adequately protect these resources. The hay bales will be anchored 4 inches into the ground with firmly entrenched stakes and placed in a continuous row. The hay bale barrier will be inspected regularly and those showing signs of deterioration will be replaced immediately. Material that has collected behind the hay bales will be removed as needed.

A silt fence will be installed in addition to the hay bales as a secondary control of erosion and siltation. Silt fence fabric selection shall be made to allow adequate passage of water. Stakes used to construct silt fences shall be manufactured of wood with squared, butt ends and tapered driving points. Filter fabric shall be stapled or tied to the wood stakes with jute twine. All silt fence shall be removed following completion of all on-site construction activities.

All sediment controls shall be cleaned on a regular basis. At a minimum, sedimentation control devices must be cleaned when their design capacity has been reduced by 50 percent.

3.3 Stormwater Management System

The proposed landfill closure plan utilizes the existing drainage pathways and gradual slopes to direct stormwater off the landfill cap. Design of the landfill stormwater management system is in accordance with all applicable state regulations and guidelines. These regulations and all pertinent drainage swale design criteria are discussed in detail below.

3.3.1 Regulations

MassDEP Solid Waste Management Regulations (310 CMR 19.000) require that stormwater runoff from landfills discharging to wetlands be controlled during a 25-year, 24-hour storm event. The Massachusetts Stormwater Management Policy requires stormwater control for both 2- and 10-year, 24-hour storms and requires that the 100-year, 24-hour storm event be evaluated for off-site flooding impacts.

The Massachusetts Stormwater Management Policy includes ten (10) stormwater management standards which need to be considered for new or redevelopment projects. For redevelopment of a previously developed site, as is the case with the Hamilton Landfill, projects must meet the stormwater management standards to the maximum extent practicable. At the very least, the stormwater system must be designed to improve existing conditions. The ten stormwater management standards include:

- No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to, or cause erosion in, wetlands or waters of the Commonwealth.
- Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-developed peak discharge rates.
- Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.
- For new development, stormwater management systems must be designed to remove 80 percent of the average annual load (post-development conditions) of Total Suspended Solids (TSS).
- Stormwater discharges from areas with higher potential pollutant loads (as defined by the Policy) require the use of specific stormwater management BMPs. The use of infiltration practices without pretreatment is prohibited.
- Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries and recharge areas for public water supplies.
- Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable.
- Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities.

- All stormwater management systems must have an operation and maintenance plan to ensure that systems function as designed.
- Illicit discharges to the surface water management system are prohibited.

3.3.2 Stormwater Flows

The stormwater management system has been sized to adequately handle the 25-year storm event, satisfy BMP requirements, and maintain post-development flows to the surrounding wetlands within a reasonable percentage of pre-development rates. Table 3-1 summarizes pre-development and post-development stormwater flow rates for the 2-, 10-, 25-, and 100-year storm events. All stormwater runoff calculations and supporting information are provided in Appendix E.

Based on HydroCAD (Version 9.10) stormwater modeling calculations, the post-closure stormwater runoff will be reduced due to flow diversion through the infiltration basin. There is no increase in peak rates of runoff discharging to either the southeastern or northern wetlands during the 2-, 10-, 25-, and 100-year storm events.

3.4 TSS Removal

To achieve 80 percent removal of TSS during the 2-, 10-, 25- and 100-year storm events more than one BMP control must be used. Vegetated water quality swales, infiltration basins, stone level spreader, vegetated filter strip and sediment check dams will be used to achieve the TSS removal to the maximum extent practicable.

3.5 Water Quality Volume

Standards 4, 5 and 6 of the Stormwater Management Policy relate to the volume of water to be treated for different scenarios. Under post-closure conditions, there is an increase of impervious surfaces, with the construction of the low-permeability alternative pavement and soil caps. However, it should be noted that for the soil cap, a minimum of 24-inches of soil exists over the low-permeability soil layer surface which will allow for infiltration and evapotranspiration of stormwater.

The Stormwater Management Policy uses impervious areas as the basis for calculating the water quality volume to be treated. According to the Policy, 0.5 inches of runoff times the total impervious area of the post-developed site needs to be treated. There is just over 1 acre (44,413 sf) of impervious pavement area proposed for the landfill closure. The results of this standard require that 1850 cubic feet of stormwater be treated. Detention basins are among the BMPs that treat stormwater according to Standards 4 and 5 in the Stormwater Management Technical Handbook. Stormwater from this impervious area will be treated by the infiltration basin located at the north corner of the site.

Table 3-1
Summary of Stormwater Drainage Modeling

Discharge Point:	Total Runoff (cfs)							
	2-yr storm		10-yr storm		25-yr storm		100-yr storm	
	Pre-Development	Post-Development	Pre-Development	Post-Development	Pre-Development	Post-Development	Pre-Development	Post-Development
Southeast Wetlands	3.16	3.81	11.08	11.75	18.14	18.68	36.34	36.24
Northern Wetlands	5.22	3.27	14.57	8.75	22.57	13.40	42.54	24.92
Total Site Runoff [4]	**8.20**	**6.93**	**24.77**	**20.03**	**39.31**	**31.34**	**76.19**	**59.73**

Notes:

1. Discharges to southeast wetlands include sheet flow from landfill property.
2. Discharges to northern wetlands include sheet flow from landfill property and overflow from infiltration basin.
3. The northern and southeastern wetlands receive additional runoff from off site which is not included in these modeling calculations.
4. The total runoff is not additive of the runoff to the individual discharge points.

3.6 Wetland Impacts

3.6.1 Wetland Resource Areas

Wetlands scientists from CDM Smith delineated wetlands surrounding the Hamilton Landfill site in 2011 and confirmed existing wetland flags found on site. Wetlands were identified pursuant to the Massachusetts Wetlands Protection Act Regulations and the Corps' Wetlands Delineation Manual.

A wetland area located across Chebacco Road from the landfill site was previously delineated by Hancock Associates in 2009, however since this wetland is located across Chebacco Road, which acts as a surface water drainage divide, the wetland was not re-flagged by CDM Smith in 2011 for this project.

Waste is located within the 100-foot buffer zone along the southern, eastern and northern extents of the landfilled areas. Along the northern edge of Area 2, waste is in very close proximity to the northern wetland (W-3 as shown on Sheet C-4 of the plans). The wetlands to the south and southeast of the site are designated by wetland flags 1-1 through 1-14, 2-1 through 2-22, 9-1 through 9-5, and C-50 through C-54. Wetlands to the north of the site are designated by wetland flags 3-1 through 3-21. A pond located to the south of the site is designated at wetland flags 10-1 through 10-17 and wetlands across the street from the landfill site to the south are designated by flags 8-1 through 8-17. The wetlands and applicable state and town buffer zones are shown of Sheet C-1 of the design plans contained in Appendix B.

During capping construction of Area 2, the northern wetland may be disturbed if waste needs to be pulled back away from the cap in order to install the cap outside the wetland limits. Based upon test pits previously conducted as part of the CSA, it appears that waste is not located within the wetland and waste relocation from within the wetland is not anticipated.

3.6.2 Wetland Protection Measures

Erosion and sedimentation controls will be maintained in-place throughout the duration of the landfill closure construction. All erosion and sedimentation controls, including hay bales and silt fences, will be monitored and repaired, as necessary, throughout the construction and stabilization process.

Construction Measures

- Haybales and silt fence will be placed on the downgradient side of the work area within the 100-foot buffer zone and maintained until construction is complete.
- In areas where construction activities occur within the 100-foot buffer zone, disturbed areas will be seeded and mulched immediately following construction completion to stabilize soils and minimize erosion if no further alterations are anticipated for 30 or more days. In the event that this work is to take place outside of the growing season, erosion control blankets or mulch and tackifier will be used in lieu of seeding.
- For any construction activities taking place within the 100-foot buffer zone and no additional disturbances within the following 7 to 30 days, the areas will be temporarily stabilized with mulch and tackifier or erosion control blankets to minimize erosion.
- Construction equipment will access all proposed 100-foot buffer zone work areas from adjacent uplands, to the greatest extent feasible.

- No equipment refueling or equipment maintenance activities will occur within the 100-foot buffer zone. CDM Smith will also require the contractor to maintain a supply of suitable oil absorbent material with the equipment for the clean-up of accidental spills during refueling or maintenance operations.

Post-Construction Measures

- All areas disturbed by construction activities will be stabilized upon completion of the work.
- The silt fence/hay bale barrier will not be removed until the work area is stabilized.

In summary, environmental benefits from this project to the surrounding wetland areas will include:

- Improvement of site surface and ground water quality due to reduction of water infiltration into landfilled wastes.

3.7 Operation and Maintenance (O&M) Plan

The Town of Hamilton will be responsible for maintenance of the landfill cap following construction completion. The stormwater system will need to be maintained such that the controls operate properly. The Town will be responsible for both routine and long-term maintenance of the site. As part of the ongoing O&M program for the site, the following stormwater and erosion control systems will be inspected for proper operation:

- Stormwater basins including berms, spillways, and level of siltation; and,
- Vegetated swales.

A monitoring and maintenance program of the site will be proposed as part of the Post-Closure Monitoring and Maintenance Plan to be submitted to MassDEP as part of the landfill closure certification report.

Section 4
Construction Quality Assurance/Quality Control

4.1 Introduction

The purpose of a Construction Quality Assurance/Quality Control (QA/QC) plan is to provide a set of guidelines to be followed to document that all closure construction activities are performed in strict accordance with the contract design plans and specifications. When used to describe construction activities, the following definitions are commonly used for quality control and quality assurance:

- ***Quality Control*** – those actions taken by the contractor, supplier, manufacturer or installer to document that their methods, materials and workmanship are accurate and correct and meet the requirements of the design plans and specifications.

- ***Quality Assurance*** – those actions employed by the owner to document conformity with the design plans and specifications by monitoring and review of quality control activities. This is typically performed by a third party, independent of the owner or contractor, as required by Massachusetts Solid Waste Management Regulations 310 CMR 19.107(2).

In summary, quality control techniques are commonly those employed by the Contractor and quality assurance activities are usually performed by the Owner or their Engineer.

The overall QA/QC plan contains provisions for monitoring the installation of all aspects of the landfill closure construction. The following sections detail the requirements of the QA Engineer, the Contractor and the testing and installation requirements of the capping system materials.

4.2 Quality Assurance Engineer

The Owner will employ CDM Smith as a third party quality assurance engineering consultant during closure construction. This Engineer will have the responsibility of implementing the QA/QC plan for all construction activities at the site. The qualifications and responsibilities of the Engineer's staff members are listed as follows:

Project Manager

The Project Manager must have past experience in landfill construction projects, be familiar with the landfill and the closure design, be available for consultation with MassDEP, the Owner, and the Contractor as needed during construction, and be responsible to approve any design changes during construction. He or she will also review weekly construction progress reports. At the completion of construction, the Project Manager will be responsible for completing the Construction Certification Report for submittal to the MassDEP.

Construction Coordinator

The Construction Coordinator is the person in the Engineer's office assigned to implement and monitor specific compliance with the QA program during construction. This person will have previous

experience with landfill construction activities and be familiar with the project and its plans and specifications.

The construction coordinator will have the following responsibilities:

- Maintain contact with the Owner, Contractor, field staff and testing subcontractors;
- Review all shop drawings, testing results and construction reports for conformance with the design plans and specifications;
- Submit to and review with the project manager all weekly construction reports, shop drawings and testing results for conformance with the design plans and specifications; and,
- Organize all daily and weekly reports and all testing results for incorporation into the construction certification report.

Resident Project Representative (RPR)

The RPR will be at the site while cap and related construction activity is taking place to monitor construction activities and to provide on-site QA services for further protection against defects and deficiencies in the work of the Contractor. The RPR will be responsible for notifying the Owner and Construction Coordinator of any potential problems. He or she will keep a daily log book of all activities which take place on the site. This daily log book will include, at a minimum, the following information:

- Daily weather conditions including temperature, wind direction and speed, precipitation, etc.;
- Description of construction activities taking place;
- Equipment and personnel on-site;
- Description and location of any QA/QC testing being performed;
- Acceptance or failure of inspection and tests;
- Quality verification of materials received on-site and thickness placed;
- Problems encountered and actions taken;
- Description of remedial action to be taken, if required;
- On-going corrective actions; and,
- In-field modifications of design plans.

4.3 Contractor

To ensure that the landfill closure will be undertaken by a competent, experienced, reputable and reliable contractor, the following will be required of the contractor during the bidding phase of the project:

- List of all jobs involving work relating to landfill closure, completed in the last 3 years;
- A list of construction projects the firm has ongoing as of the bid date;
- A list of all the major pieces of construction equipment the Contractor has available for use on this project and the extent of ownership in each; and

The Town is required to publicly bid this construction. Bidders qualifications will be evaluated and confirmed prior to contract award.

4.4 Closure Certification Report

Within 90 days of the completion of landfill closure construction, the Owner will file a Closure Certification Report with the MassDEP. This report will include: record drawings of the closure, details of the construction activities which occurred at the site, descriptions of all quality control procedures followed during construction and daily resident inspector's reports and quality control test results.

4.5 Capping Material Testing Requirements

Quality control testing of capping materials will be performed by a certified geotechnical laboratory that is qualified in accordance with ASTM E329, latest revision. Testing procedures and sampling methods will be focused on the following critical landfill cap components:

- Low Permeability Layer
- Common Fill Layer
- Topsoil Layer
- Bituminous asphalt pavement

Below is a discussion of the specific material testing requirements for each of these items.

4.5.1 Low Permeability Layer

Material testing of the low permeability layer shall be conducted in accordance with the contract specifications, as presented in draft format in Appendix C. Testing shall be conducted at a frequency of one test per 1,500 cubic yards of material in-place for grain size analysis. Low permeability material shall meet the following grain size requirements:

Sieve Size	% Finer by Weight
1-in	100
½-in	90 - 100
No. 4	50 - 100
No. 200	<15

Permeability testing of the low permeability material shall be performed at a frequency of one test per 3,000 cubic yards of material measured in-place. The material shall have a minimum permeability of 1.0×10^{-5} cm/sec.

Environmental quality testing of the low permeability material shall be performed initially and every 1,000 cubic yards of material in place. The material must meet the limits presented in Table 2-1.

4.5.2 Common Fill

Common fill will be used in conjunction with topsoil to compose the vegetative support layer and to backfill waste relocation areas. Material testing of the common fill as part of the vegetative support layer, shall be conducted in accordance with the contract specifications, as presented in draft format in Appendix C. Testing shall be conducted at a frequency of one test per 1,500 cubic yards of material in-place for grain size analysis. Common fill shall meet the following grain size requirements:

Sieve Size	% Finer by Weight
2-in	100
No. 200	0-30

Environmental quality testing of the low permeability material shall be performed initially and every 1,000 cubic yards of material in place. The material must meet the limits presented in Table 2-1 presented in Section 2.

4.5.3 Topsoil

Topsoil will be used for the landfill closure and for re-grading waste relocation areas, and repairing any vegetated areas outside the limits of the cap disturbed during construction.

The testing requirements for topsoil are outlined in the specifications. Grain size analysis and organic content tests shall be performed at a frequency of one test for every 1,000 cubic yards of topsoil to be placed at the site. Environmental sampling of the topsoil shall include RCRA 8 metals and poly-aromatic hydrocarbons (PAH's), in which results must comply with RCS-1 Standards or MassDEP background limits, whichever is lower.

The seed to be used for the topsoil shall be premixed and delivered with a manufacturer's certificate of compliance to the specifications.

4.5.4 Bituminous Asphalt Pavement

Bituminous asphalt pavement will be used for the alternative pavement cap area (primarily Area 1A) and the paved access road atop waste. Source/batch plant testing will be conducted to prepare a mix design that will meet design requirements. The Marshall Method will be used to determine the performance of the mix. The batch plant operation will be monitored to determine certifications for scales and mixing equipment, temperature of mix and methods of handling and loading.

The RPR shall be present during the pavement placement to observe placement, thickness, compaction temperature of mix, acceptability of weather, and other requirements of the specifications per Section 02576. The references standard cited in the specifications is the Department of Public Works Standard Specifications for Highways and Bridges of the Commonwealth of Massachusetts, latest edition, including all addenda (DPWSSHB).

Appendix A

MassDEP Approvals/Correspondence

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Northeast Regional Office • 205B Lowell Street, Wilmington MA 01887 • 978-694-3200

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

April 16, 2013

Mr. Michael A. Lombardo
Town of Hamilton
P.O. Box 429
Hamilton, Massachusetts 01936

RE: Hamilton – Solid Waste/COR
Chebacco Road
Hamilton Landfill
FMF No.: 39326
BWP SW 24 - Corrective Action Alternative Analysis
Transmittal No.: X251487
Decision - Approval

Dear Mr. Lombardo:

On May 16, 2012, the Massachusetts Department of Environmental Protection, Northeast Regional Office, Bureau of Waste Prevention, Solid Waste Management Section ("MassDEP"), received an application category BWP SW 24 – *Corrective Action Alternative Analysis* (the "CAAA") for the Town of Hamilton landfill located on Chebacco Road in Hamilton, Massachusetts (the "Landfill"). The CAAA was prepared and submitted to MassDEP on behalf of the Town of Hamilton (the "Town") by CDMSmith of Cambridge, Massachusetts. As discussed below, the CAAA presents and evaluates alternative corrective action approaches for the construction of a final cap on the Landfill.

DISCUSSION

The Landfill occupies approximately 12.7 acres of a 50 acre parcel owned by the Town on Chebacco Road in Hamilton. The Town's surface water supply, Gravelly Pond, is located approximately 400 feet west of the Landfill.

The Town operated the Landfill from circa 1959 until the early 1970s as a burn dump. Thereafter, until 1983 the Town operated the Landfill as a sanitary landfill for the disposal of municipal solid waste.

The sanitary landfill consisted primarily of two areas, Area 1 occupies approximately 7.1 acres and ceased operation in 1980; the second, Area 2 consists of approximately 2.9

acres and operated from 1980 until 1983. Three additional areas adjacent to Areas 1 and 2 (Areas 1A, 2A and 2B) used for landfilling were discovered during the Comprehensive Site Assessment ("CSA").

On December 21, 1977, in a letter to the Town, MassDEP concurred with the conceptual design ("Conceptual Closure Design") proposed for the closure of the Landfill and required that the Town submit final design plans to MassDEP for review and approval, and complete the final closure of the Landfill on or before July 1, 1980. On December 18, 1979, MassDEP approved the final design plans, dated July 1979, ("1979 Plans") for the closure of Area 1 and allowed the interim operation of the Landfill in Area 2. Copies of the 1979 Plans could not be located in MassDEP, the Town, or CDMSmith files. However, based on the record, the final design as approved by MassDEP is not believed to have differed substantially from that of the Conceptual Closure Design.

On June 23, 1980, the Town's consultant, Camp Dresser and McKee, Inc. certified to MassDEP that the closure of area "west of the groundwater divide" (Area 1) was complete. MassDEP approved the scope of work for the CSA on September 13, 2006 and the CSA Report on January 8, 2009.

The CSA Report, in part:

- Documents that portions of Area 1 did not contain the thickness of cover proposed in the Conceptual Closure Design.

- Documents that Areas 1A, 2, 2A, and 2B had not been covered or capped in accordance with the 1977 conceptual design. Instead, varying thicknesses (6 inches to 48 inches) of material consisting of loam, sand, silt, clay, and organic material were found to cover those areas.

- Concludes that the Landfill does not present a significant risk to human health, safety, or the environment.

CDMSmith evaluated the following Corrective Action Alternatives in the CAAA for Area 1:

- *No Further Action:* Alternative (includes the removal of shrubs and vegetation on the surface of Area 1 and restoration of vegetation).

- *Augment the Existing Cap:*

    - Option 1 – Strip the existing sand and topsoil layers place an additional 12 inch thick layer of silty soils over the area; and screen and replace the stripped topsoil to a minimum thickness of 4 inches and re-vegetate; and
    - Option 2 – Strip off existing vegetation and place a minimum 8-inch thick layer of topsoil on top of the remaining surface and re-vegetate the surface.

- *Standard Cap:* install a standard cap meeting the current design standards under 310 CMR 19.112.

The CAAA proposes the No Further Action alternative be implemented as the corrective action for Area 1, excluding the northern portion (Area 1A) that abuts Area 2 of the Landfill. CDMSmith concludes in the CAAA that implementation of the other proposed alternative will not significantly improve the protectiveness or effectiveness of the cap beyond that of the recommended No Further Action alternative.

CDMSmith evaluated the following three corrective action alternatives for Areas 1A, 2, 2A, and 2B:

- *No Further Action*: No alteration to the existing conditions in these areas.

- *Three Foot Soil Cap*: Three foot cap of clean cover soil consisting of a 30-inch thick base soil layer with a 6-inch thick topsoil layer. In response to a June 8, 2012, meeting with MassDEP, on June 11, 2012, CDMSmith submitted a revised conceptual design that provided for a three foot soil cap consisting of a 12-inch thick base layer of soil with a permeability of **not** greater than 10^{-5} cm/sec, an 18-inch thick intermediate soil layer of "Common Fill", and a6-inch thick topsoil layer with an organic content of not less than 3% organics.

- *Standard Cap*: Installation of a standard cap meeting the current design standards under 310 CMR 19.112.

DECISION

MassDEP has determined that the application as conditioned by this decision, complies with the requirements of 310 CMR 19.000. Therefore, in accordance with M.G.L. Chapter 111, § 150A and 310 CMR 19.000, MassDEP approves the CAAA subject to the Town's compliance with the following conditions imposed by MassDEP pursuant to 310 CMR 19.043(1) and 310 CMR 19.150(2)(a).

1. Compliance with 310 CMR 19.000 including, but not limited to section 310 CMR 19.043(5) *Standard Conditions* of the Solid Waste Management Regulations.
2. Compliance with 310 CMR 40.0000, the Massachusetts Contingency Plan including, but not limited to section 310 CMR 40.0114 Solid Waste Management Facilities.
3. The Town of Hamilton shall on or before July 1, 2013, submit to MassDEP, pursuant to 310 CMR 4.000 and 310 CMR 19.151, an application category BWP SW25 *Corrective Action Design* for approval of the Corrective Action Design Plan (CAD) for the restoration of Area 1 and the closure of Areas 1A, 2, 2A, and 2B of the Landfill. The CAD shall, without limitation:
    a. Restore Area 1 of the Landfill to a condition consistent with the Conceptual Closure Design;

b. Cap Areas 1A, 2, 2A, and 2B with an alternative cap consisting of a 12-inch thick base layer of low permeability soil with a permeability of **not** greater than 10^{-5} cm/sec, an 18-inch thick intermediate soil layer, and a 6-inch thick top soil layer with an organic content of not less than 3% organics, as depicted in the *"Proposed 3 Foot Alternative Cover"* design that CDMSmith submitted to MassDEP on June 27, 2012 by email and is attached hereto as Attachment I to this decision;

c. Demonstrate that any alternative final cover system, including but not limited to that described in Condition 3.b., above, meets the standards of 310 CMR 19.105, *Equivalency Review Standards and Procedures*; and

d. Include supporting design documentation including, without limitation, storm water calculations for the performance of the cap.

4. This decision does not restrict the Town of Hamilton from submitting an application for review and approval of an alternative to the Corrective Action Design(s) identified in Condition 3 above.

NOTICE OF RIGHT TO APPEAL

The Town of Hamilton (the "Town") is hereby notified that it may within twenty-one (21) days file a request that this decision be deemed a provisional decision under 310 CMR 19.037(4)(b), by submitting a written statement of the basis on which the Town believes it is aggrieved, together with any supporting materials. Upon timely filing of such a request, the decision shall be deemed a provisional decision with an effective date twenty-one (21) days after the MassDEP's receipt of the request. Such a request shall reopen the administrative record, and the MassDEP may rescind, supplement, modify, or reaffirm its decision. Failure by the Town to exercise the right provided in this section shall constitute a waiver of the Town's right to appeal.

Appeal. Any person aggrieved by the issuance of this decision may file an appeal for judicial review of said decision in accordance with the provisions of M.G.L. c. 111, s. 150A, and M.G.L. c. 30A, not later than thirty (30) days following the receipt of the final decision. The standing of a person to file an appeal and the procedures for filing such appeal shall be governed by the provisions of M.G.L. c. 30A. Unless the person requesting an appeal requests and is granted a stay of the terms and conditions of the decision by a court of competent jurisdiction, the decision shall remain effective.

Notice of Action. Any aggrieved person intending to appeal this decision to the Superior Court shall first provide notice to the MassDEP of their intention to commence such action. Said notice of intention shall include the MassDEP's file number and shall identify with particularity the issues and reasons why it is believed the decision was not proper. Such notice shall be provided to the Office of General Counsel of the MassDEP and the Regional Director for the regional office which processed the application. The appropriate addresses to which to send such notices are:

General Counsel
Massachusetts Department of Environmental Protection
One Winter Street – 3rd Floor
Boston, MA 02108

Eric Worrall, Acting Regional Director
Massachusetts Department of Environmental Protection
Northeast Regional Office
205B Lowell Street
Wilmington, MA 01887

No allegation shall be made in any judicial appeal of this decision unless the matter complained of was raised at the appropriate point in the administrative review procedures established in those regulations, provided that a matter may be raised upon a showing that it is material and that it was not reasonably possible with due diligence to have been raised during such procedures or that matter sought to be raised is of critical importance to the environmental impact of the permitted activity.

Should you have any questions regarding this letter, please contact me at (978) 694-3299.

Sincerely,

_____

John A. Carrigan, Chief
Bureau of Waste Protection
Solid Waste Management Section

JAC/ jac

Certified Mail: 7011 2970 0003 1799 0123

Cc: Bruce Haskell
CDM
One Cambridge Place
50 Hampshire Street
Cambridge MA 02139
Email: HaskellBW@cdm.com-

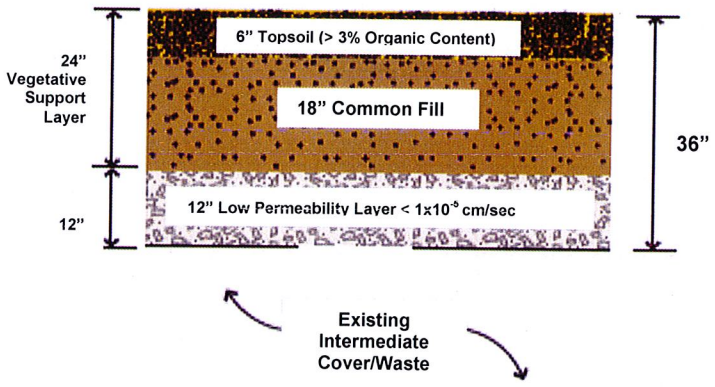
Gail Messelaar, Hamilton Board of Health Administrative Assistant,
Hamilton Town Hall
577 Bay Road
P.O. Box 429
Hamilton, MA 01936
Email: gmesselaar@hamiltonma.gov

Paul Emond MassDEP\Boston-BWP
Email: Paul.Emond@state.ma.us

ATTACHMENT I

"Proposed 3 Foot Alternative Cover"

June 27, 2012



Proposed 3-Foot Alternative Cover

Not To Scale

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
NORTHEAST REGIONAL OFFICE
205B Lowell Street, Wilmington, MA 01887 • (978) 694-3200

DEVAL PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

IAN A. BOWLES
Secretary

LAURIE BURT
Commissioner

This is an electronic facsimile of a document on file with the Massachusetts Department of Environmental Protection.

January 28, 2009

Mr. Steven Kenney, Director
Town of Hamilton
Department of Public Works
P.O. Box 429
Hamilton, Massachusetts 01936

RE: Hamilton – Solid Waste/COR
Chebacco Road
Hamilton Landfill
Comprehensive Site Assessment
Conditional Approval
Trans # X225251
FMF: 39326

Dear Mr. Kenney:

The Massachusetts Department of Environmental Protection, Northeast Regional Office, Bureau of Waste Prevention, Solid Waste Management Section ("MassDEP"), has reviewed the Town of Hamilton's (the "Town") application, transmittal number X225251, for approval of the Comprehensive Site Assessment ("CSA"), dated November 5, 2008, for the Hamilton Landfill (the "Landfill") located on Chebacco Road in Hamilton, Massachusetts. SEA Consultants Inc. ("SEA") of Cambridge, Massachusetts prepared and submitted the application to MassDEP on behalf of the Town.

Background

The Landfill consists of approximately 12.7 acres located within a 50 acre parcel owned by the Town on Chebacco Road in Hamilton. The Town's surface water supply, Gravelly Pond, is located approximately 400 feet west of the Landfill. The Town operated the Landfill from circa 1959 to 1983.

The Landfill operated as an open burn dump from 1959 until the early 1970s and thereafter as a sanitary landfill for the disposal of municipal solid waste. The sanitary landfill consisted primarily of two areas. Area 1, approximately 7.1 acres, ceased operation in 1980 and the second, Area 2, approximately 2.9 acres, operated from 1980 until 1983. Three additional areas adjacent to Areas 1 and 2 (Areas 1A, 2A and 2B) used for landfilling were discovered during the test pit excavations. The CSA states that a plan for capping and closing Area 1 was approved by the MassDEP in a December 21, 1977 letter to the Town and the capping of Area 1 was completed in the late 1970s.

The CSA assessment activities included, without limitation:

- The installation of forty-one (41) test pits to delineate the limits of waste and evaluate the existing cover material/cap;
- The installation of eight groundwater monitoring wells, twenty-four (24) landfill gas sampling points and three (3) stream piezometers;
- The collection and analysis of groundwater, surface water, sediment and soil gas samples; and
- Investigation of the impact of the activities of the Hamilton Rod and Gun and Club and Miles River Marsh Rats Club located on the property that includes the Landfill.

In Area 1, the test pits indicated that the cover material/cap consists of a top soil underlain by silty sand and fine to medium sand and that the thickness of the cover varies from twelve (12) to thirty (30) inches, with approximately half of the test pits showing the cover material is at least twenty-four (24) inches in thickness. Test pits from Area 1A, 2A and 2B indicated the cover material in those areas varies from six (6) inches to forty-eight (48) inches in thickness and consists of an organic silt (dredge material), gravelly sand, silty sand and topsoil. Test pits in Area 2 indicated that the cover material consists of loam, sand, silt and clay varying in thickness from fifteen (15) to forty-two (42) inches.

MassDEP concurs that the capping plan for Area 1 was approved by the MassDEP's letter of December 21, 1977. However, as discussed above, the CSA demonstrates that portions of Area 1 do not contain the approved thickness of cover material. In addition, the CSA suggests the perimeter drainage controls were not installed at the perimeter of the Landfill as required by the approved plan.

In addition, the CSA shows there is no consistency in the thickness or type of material in the cover material placed on Area 2. There is also no known closure plan approved by the MassDEP for Area 2. Therefore, MassDEP believes the cover material placed on Area 2 does not comply with any approved design or the current regulations. With regards to Areas 1A, 2A and 2B, the CSA states that the areas were not covered or capped in accordance with any plans approved by MassDEP.

Based on the environmental monitoring program results and the Qualitative Risk Assessment conclusions, the CSA concludes that the Landfill represents a condition of No Significant Risk to public health, welfare, safety or the environment.

The CSA concludes the lead and arsenic found in sediment sample, SED-2, in the drainage ditch immediately to the south of the rifle range may be attributed to the rifle range and not the Landfill. The CSA therefore recommends that this should be pursued under the guidelines of MassDEP's Lead Shot Initiative and not as part of the Landfill assessment and closure. In addition, the CSA states the Town will encourage the Hamilton Rod and Gun and Club and Miles River Marsh Rats Club to implement best management practices at their ranges including shot collection and recycling.

The CSA also proposes to reduce sampling frequency, eliminate sampling locations and reduce laboratory analysis from the existing environmental sampling program conducted during the CSA. However, one year of data is insufficient for evaluating this proposal.

Decision

MassDEP has reviewed the CSA pursuant to 310 CMR 19.000, the Solid Waste Management Regulations, and for consistency with the guidelines of MassDEP's Landfill Technical Guidance Manual (DEP Publication No. SWMID: 001-91-G, Rev. 5/97). MassDEP approves the CSA subject to compliance with the following conditions.

1. The Town shall on or before May 1, 2009 submit a Scope of Work for conducting a Corrective Action Alternative Analysis (CAAA) that includes:

   a. Corrective Action Alternatives for the closure of the Landfill that include, without limitation, the following alternatives:
      - No action,
      - Restoration of the Area 1 cap to the original design,
      - Capping in accordance with the current design standards of 310 CMR 19.000,
      - Excavation and relocation of waste from Area 1A, 2A and 2B to beneath the Area 2 cap, and
      - Any other alternative cap in accordance with 310 CMR 19.113.

   b. Evaluates the need for the installation of landfill gas controls.

2. MassDEP does not approve the proposed Post-CSA Environmental Monitoring Plan. The Town shall conduct environmental monitoring of the existing groundwater, surface water, sediment and soil gas sampling network at the landfill in accordance with 310 CMR 19.132 and the approved CSA, until otherwise approved in writing by MassDEP. This shall include conducting the landfill gas monitoring quarterly and groundwater and surface water monitoring semi-annually.

This Decision is issued by MassDEP under the authority of M.G.L., Chapter 111, Section 150A and 310 CMR 19.000. All activities shall be implemented in compliance with 310 CMR 40.0114 Solid Waste Management Facilities of the Massachusetts Contingency Plan and in a manner consistent with the Landfill Guidance Manual (1997).

NOTICE OF RIGHT TO APPEAL

The Town of Hamilton is hereby notified that it may within twenty-one (21) days file a request that this decision be deemed a provisional decision under 310 CMR 19.037(4)(b), by submitting a written statement of the basis on which the Town believes it is aggrieved, together with any supporting materials. Upon timely filing of such a request, the decision shall be deemed a provisional decision with an effective date twenty-one (21) days after MassDEP receipt of the request. Such a request shall reopen the administrative record, and MassDEP may rescind, supplement, modify, or reaffirm its decision. Failure by the Town to exercise the right provided in this section shall constitute a waiver of the Town right to appeal.

Appeal. Any person aggrieved by the issuance of this decision, except as provided for under 310 CMR 19.037(4)(b), may file an appeal for judicial review of said decision in accordance with the provisions of M.G.L. c. 111, s. 150A, and M.G.L. c. 30A, not later than thirty (30) days following the receipt of the final decision. The standing of a person to file an appeal and the procedures for filing such appeal shall be governed by the provisions of M.G.L. c. 30A. Unless the person requesting an appeal requests and is granted a stay of the terms and conditions of the decision by a court of competent jurisdiction, the decision shall remain effective.

Notice of Action. Any aggrieved person intending to appeal this decision to the Superior Court shall first provide notice to MassDEP of their intention to commence such action. Said notice of intention shall include MassDEP file number and shall identify with particularity the issues and reasons why it is

believed the decision was not proper. Such notice shall be provided to the Office of General Counsel of MassDEP and the Regional Director for the regional office which processed the application. The appropriate addresses to which to send such notices are:

General Counsel
Department of Environmental Protection
One Winter Street - Third Floor
Boston, MA 02108

Richard J. Chalpin, Regional Director
Department of Environmental Protection
Metropolitan Boston/Northeast Regional Office
205B Lowell Street,
Wilmington, MA 01887

No allegation shall be made in any judicial appeal of this decision unless the matter complained of was raised at the appropriate point in the administrative review procedures established in those regulations, provided that a matter may be raised upon a showing that it is material and that it was not reasonably possible with due diligence to have been raised during such procedures or that matter sought to be raised is of critical importance to the environmental impact of the permitted activity

Should you have any questions regarding this letter, please contact John Morey at (978) 694-3297.

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John P. Morey
Environmental Analyst

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John A. Carrigan
Section Chief
Solid Waste Management

JAC/JPM/jac/jpm

Cc: Stephen Wright P.E., (Electronic Copy)
SEA Consultants Inc.
485 Massachusetts Ave,
Cambridge MA 02139-4018
Email: Stephen.Wright@seacon.com

Gail Messelaar, Hamilton Board of Health Administrative Assistant,
Hamilton Town Hall
577 Bay Road
P.O. Box 429
Hamilton, MA 01936
Email: gmesselaar@hamiltonma.gov

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
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MITT ROMNEY
Governor

KERRY HEALEY
Lieutenant Governor

ROBERT W. GOLLEDGE, Jr.
Secretary

ARLEEN O'DONNELL
Commissioner

This is an electronic facsimile of a document on file with the Massachusetts Department of Environmental Protection.

September 13, 2006

Mr. Steven Kenney, Director
Town of Hamilton
Department of Public Works
P.O. Box 429
Hamilton, Massachusetts 01936

RE: **Hamilton – Solid Waste/COR**
Chebacco Road
Hamilton Landfill
CSA Scope of Work
Conditional Approval
FMF: 39326

Dear Mr. Kenney:

The Massachusetts Department of Environmental Protection, Northeast Regional Office, Bureau of Waste Prevention, Solid Waste Management Section (MassDEP), has reviewed the proposed scope of work (the CSA Scope) for completing a Comprehensive Site Assessment of the Hamilton Landfill (the Landfill) located on Chebacco Road in Hamilton, Massachusetts. The CSA Scope was prepared on behalf of the Town of Hamilton (the Town) by SEA Consultants Inc. (SEA) of Cambridge, Massachusetts, and proposes, without limitation, the following activities:

- The installation of test pits at the perimeter of the Landfill and the former sludge lagoon to delineate the limits of waste.
- The installation of up to ten (10) groundwater monitoring wells, twenty four (24) landfill gas sampling points and three stream (3) piezometers.
- The collection and analysis of groundwater, surface water and soil gas samples.

The CSA Scope does not provide for the collection of sediment samples from the surface water bodies or wetlands in the vicinity of the Landfill.

MassDEP has reviewed the CSA Scope pursuant to 310 CMR 19.000, the Solid Waste Management Regulations, and for consistency with the guidelines of MassDEP's Landfill Technical Guidance Manual (DEP Publication No. SWMID: 001-91-G, Rev. 5/97). MassDEP approves the CSA Scope subject to compliance with the following conditions.

1. The Town shall modify the CSA Scope to include the collection and analysis of sediment samples at the site including, without limitation, the collection of sediment samples from the proposed piezometer locations. The samples shall be analyzed for the parameters identified at 310 CMR 19.132(1)(h). The Town shall within thirty (30) days of the date of this decision provide MassDEP with a plan showing the location of the proposed sediment samples.

2. Sufficient test pits and/or borings shall be installed to delineate the extent of the solid waste at the site.

3. In addition to the parameters identified in the CSA Scope, the landfill gas sampling points shall be screened for the presence of volatile organic compounds (VOCs). If VOCs are detected during the landfill gas screening the Town may be required to collect samples for laboratory analysis.

4. The Town shall request access from the Town of Manchester to survey and gauge existing monitoring wells at the Manchester Landfill and Water Supply Plant that are in the vicinity of the Hamilton Landfill for purposes of defining the groundwater flow. The request shall be made in writing and copies of the request and responses, if any, from the Town of Manchester shall be included as an appendix in the Comprehensive Site Assessment report.

5. All monitoring wells shall be sampled in a manner that minimizes sample turbidity, such as proper development and low flow sampling.

6. The Town shall provide sample splits to MassDEP upon request by MassDEP.

7. The UTM coordinates and surveyed elevation data for the monitoring wells and the piezometers shall be included in the CSA Report.

8. The static groundwater elevations shall be measured in all the groundwater monitoring wells and piezometers at the Landfill during each sampling round.

9. The groundwater elevation data for each well shall be summarized in a tabular format including:
   a. the actual measured depth to groundwater,
   b. the elevation of the datum,
   c. the calculated groundwater elevation, and
   d. a summary of the condition of each well.

10. All environmental sample collection and laboratory data analysis shall comply with sections 310 CMR 40.0017 Environmental Sample Collection and Analysis and 310 CMR 40.0191 Response Action Performance Standards of the Massachusetts Contingency Plan. Note that the Department's Bureau of Waste Site Cleanup's, guidance document, the Compendium of Analytical Methods (BWSC-CAM-VII A), provides guidance on meeting the requirements of 310 CMR 40.0117 and 310 CMR 40.0191. This document can be found on the Department's website at http://www.mass.gov/dep/about/qaqcdocs.htm.

11. All laboratory data shall be reported to MassDEP in a tabular format. If the concentration of an analyte is below the Practical Quantification Limit (PQL) for the analytical method used then the results for that analyte shall be reported as less than the PQL (i.e. <0.005). Laboratory data results shall not be reported as non-detect (ND), below detection limit (BDL), or zero. Copies of the actual laboratory data reports shall be included as an appendix to all reports.

12. Following completion of the four (4) quarters of environmental sampling provided for in the CSA Scope, the Town shall continue to conduct environmental monitoring at the landfill including the collection of landfill gas samples quarterly and groundwater samples semiannually. The results of the environmental sampling shall be reported to MassDEP in accordance with 310 CMR 19.132.

13. The CSA shall provide information equivalent to that of a Phase II Investigation pursuant to 310 CMR 40.0000. It shall include a conceptual model for the Landfill that includes discussion of the relationship of the Landfill to Gravelly Pond, the Manchester Public Water Supply and the Manchester Landfill. It shall also discuss the impact of the septage lagoon area on the groundwater and the potential for bedrock contamination. The CSA shall also assess the potential impact of lead shot from the shooting ranges at the property on the landfill. Information from publicly available environmental reports for abutting properties such as the Manchester Landfill and the Manchester Water Treatment Facility shall be reviewed and utilized in the CSA.

14. The Town shall notify MassDEP of any significant changes to the CSA Scope for MassDEP review and approval.

This Decision is issued by MassDEP under the authority of M.G.L., Chapter 111, Section 150A and 310 CMR 19.000. All activities shall be implemented in compliance with 310 CMR 40.0114 Solid Waste Management Facilities of the Massachusetts Contingency Plan and in a manner consistent with the Landfill Guidance Manual (1997). This Decision does not relieve the Town of its responsibility to comply with all other applicable state, federal, and local statutes, regulations, and requirements.

NOTICE OF RIGHT TO APPEAL

The Town is hereby notified that it may within twenty-one (21) days file a request that this decision be deemed a provisional decision under 310 CMR 19.037(4)(b), by submitting a written statement of the basis on which the Town believes it is aggrieved, together with any supporting materials. Upon timely filing of such a request, the decision shall be deemed a provisional decision with an effective date twenty-one (21) days after MassDEP receipt of the request. Such a request shall reopen the administrative record, and MassDEP may rescind, supplement, modify, or reaffirm its decision. Failure by the Town to exercise the right provided in this section shall constitute a waiver of the Town right to appeal.

Appeal. Any person aggrieved by the issuance of this decision, except as provided for under 310 CMR 19.037(4)(b), may file an appeal for judicial review of said decision in accordance with the provisions of M.G.L. c. 111, s. 150A, and M.G.L. c. 30A, not later than thirty (30) days following the receipt of the final decision. The standing of a person to file an appeal and the procedures for filing such appeal shall be governed by the provisions of M.G.L. c. 30A. Unless the person requesting an appeal requests and is granted a stay of the terms and conditions of the decision by a court of competent jurisdiction, the decision shall remain effective.

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General Counsel
Department of Environmental Protection
One Winter Street - Third Floor
Boston, MA 02108

Richard J. Chalpin, Regional Director
Department of Environmental Protection
Metropolitan Boston/Northeast Regional Office
205B Lowell Street,
Wilmington, MA 01887

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Should you have any questions regarding this letter, please contact John Morey at (978) 694-3297.

Sincerely,

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John P. Morey
Environmental Analyst

Sincerely,

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John A. Carrigan
Section Chief
Solid Waste Management

JAC/JPM

Cc: Stephen Wright P.E., (Electronic Copy)
SEA Consultants Inc.
485 Massachusetts Ave,
Cambridge MA 02139-4018
Stephen.Wright@seacon.com

Appendix B
Design Plans

Appendix C
Technical Specifications

SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment required and perform all site preparation, complete as shown on the Drawings and as specified herein.

B. Unless otherwise shown on the Drawings or directed by the Engineer, the areas to be grubbed and stripped are minimal.

C. Protection of trees (including roots) marked by Engineer.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. Sedimentation and Erosion Control is included in Section 02270.

C. Topsoil and Hydroseeding is included in Section 02930.

PART 2 PRODUCTS - (NONE THIS SECTION)

PART 3 EXECUTION

3.01 CLEARING

A. Cut and remove all timber, trees, stumps, brush, shrubs, roots, and any other objectionable material resting on or protruding through the surface of the ground within the limits of work.

B. Preserve and protect trees and other vegetation designated on the Drawings or directed by the Engineer to remain as specified below. Existing vegetation outside the limit of work shall be protected and clearing shall be minimized to only necessary areas.

C. Contractor is responsible for handling and removal of trees, brush and on-site leaf and yard waste to an off-site location.

D. Cut and remove all timber, trees, stumps, brush, shrubs, roots, and any other objectionable material resting on or protruding through the existing capped surface of Area 1 as designated on the Drawings.

3.02 GRUBBING

A. Grub and remove all stumps, roots in excess of 1-1/2-in in diameter, matted roots, brush, timber, and logs encountered to a depth of 18-in below original grade or 18-in beneath the bottom of foundations, whichever is deeper.

B. Beyond the limit of the cap, but within the limit of work, refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface in accordance with Section 02200.

C. Contractor is responsible for handling and removal of stumps. Stumps may not be disposed of within the landfill.

3.03 STRIPPING

A. Clean stripped materials may be reused on-site as designated by the Engineer. Avoid mixing topsoil with subsoil.

B. Strip topsoil from all areas to be excavated or filled.

C. Stockpile and protect topsoil until it is used for loaming and seeding. Contractor is responsible for ensuring stockpiled topsoil meets the requirements of Section 02930.

3.04 DISPOSAL

A. All timber, trees, brush and shrubs shall be disposed off-site.

B. Burning of cleared and grubbed materials, or other fires for any reason will not be permitted.

C. All asphalt, concrete, brick and metal materials shall be disposed of off-site.

D. All excess clean fill material shall be disposed of off-site.

E. All materials stored on site as part of the Owners DPW Operations shall be relocated on site, disposed of, or reused on site as appropriate and as approved by the Engineer.

3.05 PROTECTION

A. Trees and other vegetation directed by the Engineer to remain shall be protected from damage by all construction operations by erecting suitable barriers, guards and enclosures, or by other approved means. Conduct clearing operations in a manner to prevent falling trees from damaging other trees and vegetation designated to remain and to the work being constructed and so as to provide for the safety of employees and others.

B. Maintain protection until all work in the vicinity of the work being protected has been completed.

C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees.

D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the work shall immediately be cut off cleanly inside the exposed or

damaged area. Treat cut surfaces with an acceptable tree wound paint and topsoil spread over the exposed root area.

E. When work is completed, remove all dead and downed trees. Live trees shall be trimmed of all dead and diseased limbs and branches. All cuts shall be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches. Cuts over 1-in in diameter shall be treated with an acceptable tree wound paint.

F. Restrict construction activities to those areas within the limits of construction designated on the Drawings, within public rights-of-way, and within easements provided by the Owner. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored to their original condition, to the full satisfaction of the property owner.

G. Do not operate heavy equipment or stockpile materials within the wetlands, to the extent practicable.

3.06 COORDINATION

A. Contractor shall submit a schedule and an operations plan for the phasing of the work. The plan should provide a schedule for completion of each phase of work in this area and should detail the measures and stockpile staging to be taken to maintain access during construction.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.00 STATUTORY REQUIREMENTS

A. All excavation, trenching, sheeting, bracing, etc shall comply with the requirements of OSHA excavation safety standards (29 CFR PART 1926.650 Subpart P).

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment supervision and incidentals necessary to perform all excavation, backfill, fill and grading required to complete the work shown on the Drawings and specified herein. The work shall include, but not necessarily be limited to, excavation of earth and waste for grading, as shown on the Drawings; constructing embankments; miscellaneous earth excavation; filling, backfilling, grading and such other operations; control of water; control of leachate outbreaks as required; and appurtenant work, complete, in accordance with the Drawings and Specifications, all related work and as directed by the Engineer.

B. Furnish and install temporary excavation support systems, including sheeting, shoring and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc, in accordance with federal, state and local laws, regulations and requirements.

C. All excavation, trenching, sheeting, bracing, etc shall comply with the requirements of OSHA excavation safety standards as identified above in Paragraph 1.00 A. and to the Massachusetts Department of Labor Industries, Division of Industrial Safety "Rules and Regulations for the Prevention of Accidents in Construction Operations" (Chapter 454 CMR 10.00 et seq.). Where conflict between OSHA and State Regulations exist, the more stringent requirements shall apply.

D. Wherever 90 percent compaction is referred to herein, it shall mean at least 90 percent of the maximum dry density as determined by ASTM D1557.

1.02 RELATED WORK

A. Testing and Testing Laboratory Services is included in 01410.

B. Site Preparation is included in Section 02100.

C. Sedimentation and Erosion Control is included in Section 02270.

D. Bituminous Concrete Pavement is included in Section 02576.

E. Miscellaneous Work is included in Section 02901.

F. Topsoil and Hydroseeding is included in Section 02930.

G. Waste Relocation, including test pitting, is included in Section 13612.

1.03 SUBMITTALS

A. Submit the proposed methods of construction, including excavation, dewatering, excavation support systems designs, backfilling and filling and compaction for the various portions of the Work. Excavation support system designs, if needed, shall be prepared by a licensed professional engineer, registered in the Commonwealth of Massachusetts, and having a minimum of five years of professional experience in the design and construction of excavation support systems. Review will be for information only. Contractor shall remain responsible for adequacy and safety of construction means, methods, and techniques.

B. Fill Materials: For each off-site source of fill material the Contractor shall provide the Engineer written notification of the proposed source of the material and shall deliver a representative sample weighing approximately 50 lbs at least 10 calendar days prior to the date of anticipated use of such material. For each non-structural fill material, the Contractor shall submit a representative grain size analysis to the No. 200 sieve and Moisture Density Relationship Curve. All testing shall be performed at a certified soils testing laboratory at the Contractor's own expense.

C. Analytical Testing: For each source of fill materials, the contractor shall supply certificates attesting that analysis was conducted by a Massachusetts Department of Environmental Protection approved laboratory for the parameters specified herein.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D698 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregates Mixtures Using 5.5 lbs (2.49 kg) Rammer and 12-in (305-mm) Drop. (Also known as Standard Proctor Analysis)

2. ASTM D1557 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 10-lb (4.54 kg) Rammer and 18-in (457 mm) Drop. (Also known as Modified Proctor Analysis)

3. ASTM D2434 - Test Method for Permeability of Granular Soils

4. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils

5. ASTM D5321 - Test Method for Determining the Coefficient of Soil and Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The Quality Control and Quality Assurance consists of laboratory conformance testing of samples supplied from each granular fill source and quality control during installation.

B. The Contractor will retain an independent laboratory (QAL) that has adequate equipment to perform the required conformance tests (during construction) of the granular fill and provide results in a timely manner in accordance with the Specifications. Coordinate and schedule all tests as required by the Drawings and Specifications.

C. Conformance testing requirements are specified in Paragraph 1.06. The purpose of conformance testing is to assure the supplied granular fill from each source is consistent and conforms to the Specifications.

D. Field Quality Control requirements are specified in Paragraph 3.10. The purpose of field quality control procedures is to assure that the granular fill layers have been installed in accordance with the Specifications.

1.06 SOIL TESTING

A. Previous to the general placement of fill and during such placement, the Engineer may select areas at random within the limits of the fill for testing the degree of compaction obtained. The Contractor shall cooperate fully in obtaining the desired information. Payment for such testing will be made by the Owner. If test results are unsatisfactory, all costs associated with obtaining acceptable results, as deemed by the Engineer, will be borne by the Contractor.

B. Environmental Laboratory Testing:

1. Prior to the delivery of backfill and capping soils to the site, the Contractor shall provide the following environmental tests for each source (additional to source geotechnical testing requirements contained in Paragraph 1.03 B. and conformance testing contained in 4 below) and demonstrate that the source is below the following standards:

Parameter	Test Method	Maximum Detection Limit	Allowable Concentration
PAHs:	EPA 8270	½ of allowable concentration	
Acenaphthene			<4
Acenaphthylene			<1
Anthracene			<10
Benzo(a)Anthracene			<7
Benzo(a)pyrere			<2
Benzo(b)Fluoranthene			<7
Benzo(ghi)Perylene			<10
Benzo(k)Fluoranthene			<10
Chrysene			<20
Dibenzo(a,h)Anthracene			<0.7
Fluoranthene			<40
Fluorene			<10
Indeno(1,2,3-cd)Pyrene			<7
2-Methynaphthalene			<0.7
Naphthalene			<4
Phenanthrene			<10
Pyrene			<40

Metals: Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium (Total) Cobalt Copper Iron Lead Magnesium Manganese Mercury Nickel Selenium Silver Thallium Vanadium Zinc	MCP 6000/7000 Series	½ of allowable concentration	<25,000 <10 <20 <375 <4 <2 <30 <40 <300 <50,000 <300 <12,500 <1,500 <3 <20 <5 <6 <6 <225 <500

Notes
1. "S-1 MCP" is the concentration of a specific constituent contained in Table 2, Section 310 CMR 40.0975(6)(a) of the Massachusetts Contingency Plan under column entitled "S-1 Soil & GW-1".
2. "Natural Soils" are the concentrations in the column under the same title in Table 1 of MassDEP guidance document entitled "Technical Update, Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soils" dated May 2002.

2. For every 1,000 cubic yards of backfill and capping soils delivered to the site, or portion of 1,000 cubic yards, the Contractor shall provide laboratory analysis testing for PAHs, arsenic, chromium, cadmium, lead, and nickel by methods outlined and with Maximum Detection Limits as shown in 1 above. No fill or capping materials shall be used on-site if any of the parameters exceed their responding "Allowable Concentration" outlined in the table above.

3. The Owner and Engineer reserve the right to collect confirmatory samples of the backfill or capping materials on-site for laboratory analysis and to direct the removal of any soils that do not meet Specifications.

C. Geotechnical Laboratory Testing:
1. The Contractor shall perform, at his own expense, geotechnical soil testing on the backfill and capping layers to verify conformance with the design specifications. Backfill and capping layer soils shall be tested initially for acceptance as a source then at the frequency indicated below for conformance testing to ensure consistency in the material:

Type of Test	Frequency	Testing Method(s)

Grain Size Analysis (to the No. 200 Sieve plus hydrometer)	1 test/1,500 cy	ASTM D422
Moisture Density Curve	1 test/3,000 cy	ASTM D1557
Permeability	1 test/3,000 cy	ASTM D2434

1. The results from the soil testing shall be furnished to the Engineer.

2. The permeability tests shall be performed when the sample is compacted to 90 percent of its maximum dry density and set at its optimum water content as determined by ASTM D1557.

D. See Section 01410 for Testing and Testing Laboratory Services

PART 2 PRODUCTS

2.01 MATERIALS

A. Low Permeability Materials - Soils to be placed as part of the cap immediately above the re-graded waste furnished from off-site sources will be required to meet the following requirements:

1. Maximum hydraulic conductivity of $1x10^{-5}$ cm/sec when compacted to 90 percent of the maximum dry density as determined by the standard Proctor test performed in accordance with ASTM D698.

2. Low Permeability Materials shall be free of organic matter and other deleterious materials with a particle size gradation confirming the following:

Sieve Size	Percent Finer by Weight
1-in	100
½-in	90-100
No. 4	50-100
No. 200	>15

B. Common Fill shall consist of mineral soil substantially free from organic materials, loam, wood, trash and other objectionable materials which may be compressible or which cannot be properly compacted. Common fill shall not contain stones larger than two inches in largest diameter and shall have a maximum of 30 percent passing No. 200 Sieve. Common fill shall not contain granite blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice and frozen soil will not be permitted.

C. Structural Fill

1. Structural Fill (bank run gravel) shall be gravel, sandy gravel, or gravelly sand free of organic material, loam, wood, trash, snow, ice, frozen soil and other objectionable material and shall be well graded within the following limits:

Sieve Size	Percent Finer by Weight

3-in	100
No. 4	20 - 70
No. 40	5 - 35
No. 200	0 - 7

2. The Contractor shall submit to the site a representative sample of proposed structural fill, weighing approximately 50-lbs, at least ten days prior to the date of anticipated use of such material.

E. Screened Gravel

1. Screened gravel shall consist of hard, durable particles of proper size and gradation, free from sand, loam, clay, excess fines and deleterious materials. The size of the particles shall be uniformly graded gravel and conform to the following gradation:

Sieve Size	Percent Finer by Weight
1/2-in	95-100
3/8-in	40 - 70
No. 4	0-5

F. Dense-graded Crushed Stone

1. Coarse aggregate shall be hard, durable particles of fragmented stone of proper size and gradation and shall conform to MassDOT Standard Specification for the Highways and Bridges M2.01.7. Fine aggregate shall consist of natural or crushed sand. The composite material shall be free from loam, clay, excess fines, and other deleterious materials.

G. Processed Gravel Subbase

1. Gravel shall be used at locations indicated in the Drawings.
2. Processed gravel for pavement subbase shall conform to M1.03.1 of the MassDOT SSHB specifications.

H. Woven Geotextile

1. All geotextile shall be a woven monofilament polypropylene fabric consisting of filaments formed into a stable network, such as Mirafi FW404 or equal.

2. The geotextile shall be a woven monofilament material consisting of polypropylene formed into a stable network such that the filament retains their relative position to each other. The material shall be nonbiodegradable, nonreactive within a pH range of three to eleven, resistant to ultraviolet light exposure, and resistant to insects and rodents. Test results from any sampled roll in the lot, when tested in accordance with ASTM D4759, shall meet or exceed the values listed in Table 1.

3. TABLE 1: WOVEN GEOTEXTILE MINIMUM AVERAGE ROLL VALUES FOR WOVEN FABRICS

PROPERTIES	TEST METHOD	UNIT	MINIMUM AVERAGE ROLL VALUES

			Machine Direction (MD)	Cross Direction (CD)
Wide Width Tensile Strength	ASTM D4595	lbs/in	270	270
Grab Strength	ASTM D4632	lb	400	315
Grab Elongation	ASTM D4632	%	15	15
Trapezoid Tear Strength	ASTM D4533	lbs	150	165
Mass per Unit Area	ASTM D5261	oz/yd2	8.8	
Puncture Strength	ASTM D6241	lb	1150	
UV Resistance	ASTM D4355	% Strength Retained	90	
Apparent Opening Size (Max)	ASTM D4751	US Std. Sieve	40	
Percent Open Area (POA)	CW-02215 Mod.	%	1	
Permittivity	ASTM D4491	sec-1	0.9	
Water Flow Rate	ASTM D4491	gpm/ft2	70	

1. All strength values are in the weaker principal direction.

I. Nonwoven Geotextile (Filter Fabric)

1. The geotextile shall be a nonwoven needle punched material consisting of continuous filaments formed into a stable network. The material shall be nonbiodegradable, nonreactive within a pH range of three to eleven, resistant to ultraviolet light exposure and shall meet the following minimum average roll values:

MINIMUM AVERAGE ROLL VALUES

Min. Avg. Roll Values

Properties	Test Method	Unit	6 oz.
Fabric Weight	ASTM D3776	oz/yd^2	6.0
Grab Strength	ASTM D4632	lbs	160
Grab Elongation	ASTM D4632	%	50
Puncture Resistance	ASTM D4833	lbs	90
Mullen Burst Strength	ASTM D3786	PSI	300
Water Flow Rate	ASTM D4491	gpm/ft^2	110
Permittivity	ASTM D4491	SEC^{-1}	1.2
Coef. of Permeability	ASTM D4491	cm/sec	0.2
Apparent Opening Size	ASTM D4751	Sieve No.	70

2. The values listed above are for the weaker principal direction.

3. Nonwoven geotextile shall be manufactured by Nicolon, Polyfelt, Spartan Technology or by an approved manufacturer meeting the above physical properties.

PART 3 EXECUTION

3.01 PREPARATION

A. Dewatering and Drainage Systems

1. Temporary dewatering and drainage systems, as appropriate, shall be in place and operational prior to beginning excavation work.

3.02 EXCAVATION

A. The Contractor shall perform all excavations of every description and of whatever substances encountered, in a manner as required to allow for installation of vent, well, drainage pipe, swales and other work and for preparation of grade. Excavations shall be to such widths as will give suitable space for the required work. Bottoms of trenches and excavations shall be protected from frost and shall be firm, dry and in an acceptable condition to receive the work. Work shall not be placed on frozen ground nor shall work be placed on wet unstable ground.

B. All excavations made in open cut will be controlled by the conditions existing at the various locations and shall always be confined to the limits as designated by the Engineer.

C. Contractor is responsible for controlling any and all odors caused by the excavation of solid waste

3.03 EXCAVATION BELOW GRADE

A. If the bottom of any excavation is taken out below the limits shown on the Drawings, specified, or directed by the Engineer, it shall be refilled at the Contractor's expense with concrete, 8-in layers of compacted structural fill or other material satisfactory to the Engineer. The type of material to be used shall be at the Engineer's option.

B. If the Contractor does not care for work properly, through failure to postpone final excavation immediately above the subgrade until shortly before placing of the new work thereon, or other failure or neglect to conduct the excavation work properly so that the surface of the subgrade is in proper condition when he/she is ready for construction, the Contractor shall remove the unsuitable material and replace it with concrete, compacted structural fill, or other approved material at his/her own expense so that the condition of the subgrade meets with the approval of the Engineer before any work is placed thereon.

C. If, in the opinion of the Engineer, the material, in its undisturbed natural condition, at or below the normal grade of the excavation as indicated on the Drawings is unsuitable for foundations, it shall be removed to such depth and width as he/she may direct and be replaced with suitable material as directed by the Engineer.

3.04 TRENCH EXCAVATION AND BACKFILLING

A. Excavation for all trenches required for the installation of pipes shall be made to the depths indicated on the Drawings and in such a manner and to such widths as will give suitable room for laying the pipe within the trenches, for bracing and supporting and for pumping and drainage facilities. Contractor shall render the bottom of the excavations firm and dry and in all respects acceptable to the Engineer. Pavement, when encountered, shall be cut with pneumatic chisels along straight lines before excavating.

B. Rock shall be removed to a minimum 8-in clearance around the bottom and sides of all the pipe being laid.

C. Where pipe is to be laid directly on the trench bottom, the lower part of the trenches in each shall not be excavated to grade by machinery, the last of the material being excavated manually in such a manner that will give a flat bottom true to grade so that pipe or duct can be evenly supported on undisturbed material.

3.05 MISCELLANEOUS EXCAVATION

A. The Contractor shall excavate and remove the existing paved areas where required. Pavement shall be disposed of off-site by the Contractor.

B. The Contractor shall perform all the remaining miscellaneous excavation. The Contractor shall make all excavations necessary to permit the placing of loam and plants, for constructing wetlands and any other miscellaneous earth excavation required under this Contract.

C. All pipe, chain link fencing, catch basins, manholes and other materials of this type shall be disposed of off-site by the Contractor.

3.06 BACKFILLING - COMMON FILL

A. Common Fill may be used as backfill where indicated; as embankment fill; or in other areas as designated by the Engineer. Material conforming to the requirements of common fill shall be placed in layers having a maximum thickness of 12-in measured before compaction.

B. Common Fill shall be compacted to at least 92 percent of maximum density as determined by ASTM D1557, Method D.

C. Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making due allowance for settlement of the material and for the placing of loam thereon.

D. The surfaces of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the grading plan and no soft spots or uncompacted areas will be allowed in the work.

E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.07 BACKFILLING - STRUCTURAL FILL

A. Structural fill shall be placed in layers having a maximum thickness of 8-in in open areas and 6-in in confined areas including points where piping joins structures, measured before compaction. Each layer of fill shall be compacted to at least 95 percent of maximum dry density determined by the ASTM D1557, Method D by methods approved by the Engineer.

B. Structural fill shall not be placed on a frozen surface or one covered by snow or ice, nor shall snow, ice or frozen earth be incorporated in the compacted fill.

C. Compaction of structural fill in open areas shall consist of a fully loaded ten-wheel trucks, a tractor dozer weighing at least 30,000 lbs and operated at full speed, a heavy vibratory roller, or any method approved by the Engineer. Compaction of structural fill in confined areas shall be accomplished by hand operated vibratory equipment or mechanical tampers approved by the Engineer. As a minimum, compaction of structural fill shall consist of four coverages of the approved equipment.

3.08 BACKFILLING - COMPACTED GRAVEL

A. Compacted gravel shall be placed in layers having a maximum thickness of 8-in measured before compaction. Each layer of fill shall be compacted to at least 95 percent of maximum dry density.

B. Compacted gravel shall not be placed on a frozen surface or one covered by snow or ice, nor shall snow, ice or frozen earth be incorporated in the compacted fill.

C. Compaction of compacted gravel in open areas shall consist of a fully loaded ten-wheel trucks, a tractor dozer weighing at least 30,000 lbs and operated at full speed, a heavy vibratory roller, or any method approved by the Engineer. Compaction of compacted gravel in confined areas shall be accomplished by hand operated vibratory equipment or mechanical tampers approved by the Engineer. As a minimum, compaction shall consist of four coverages of the approved equipment.

3.09 EARTH EMBANKMENTS-COMMON FILL

A. All organic materials, including peat and loam, and loose inorganic silt material (loess) shall be removed from areas beneath new embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable surface for the placement of the embankments. The natural subgrade shall then be compacted by at least four passes of a tractor weighing at least 30,000 lbs, a heavy vibratory roller or any method approved by the Engineer. The Engineer will waive this requirement, if, in his/her opinion, the subgrade will be rendered unstable by such compaction. The prepared subgrade shall be inspected and approved by the Engineer prior to the placement of structural fill.

3.10 INSTALLATION OF CAPPING LAYERS

A. Grub, re-grade and consolidate relocated waste and install the low permeability layer as shown on the Drawings.

B. After all waste relocation activities are complete, tested and complete, place the low permeability layer to thickness and extent as shown on the Drawings.

C. During the placement of the low permeability layer, no construction equipment shall be allowed within the limits of the adjacent wetlands. Care shall be taken to protect adjacent wetlands during cap installation.

D. The final grade shall be elevations shown on the Drawings. If waste relocation quantities differ than expected, grades on Area 2 will be modified by Engineer and Contractor to maintain maximum 4H:1V and minimum 5 percent slopes. The low permeability layer shall be compacted to a maximum of 90 percent of modified Proctor density (ASTM D1557), to obtain a permeability equal to or less than 1×10^{-5} cm/sec.

E. The moisture content of the low permeability material shall be at or slightly above the optimum moisture content during the installation of the low permeability layer. If, in the opinion of the Engineer, the low permeability material is too dry for proper compaction, spray the low permeability layer with a sufficient quantity of clean water to bring the low permeability layer to the proper moisture content. No compaction shall take place if the low permeability material is significantly saturated. Optimum water content to be established by laboratory as part of geotechnical testing specified in 1.06.C; this section.

F. No low permeability material shall be placed, spread, or compacted while the ground or low permeability material is frozen or thawing or during unfavorable weather conditions. The low permeability layer surface must be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast and/or at the completion of the compaction operations in that area in order to prevent saturation of the low permeability material.

G. Use compaction equipment to achieve sufficient compaction of low permeability layer.

H. Engineer and Contractor shall measure the thickness of the individual capping layers at a frequency of 5 tests per acre, per layer. If thickness of measured capping layer is below the required thickness, the Contractor shall add the appropriate capping material at no cost and re-grade and compact the failed area to the Engineers satisfaction. Final layer thickness following adjustment shall be re-tested and verified by the Engineer.

3.11 DISPOSAL OF SURPLUS MATERIAL

A. No excavated materials shall be removed from the site of the work or disposed of by the Contractor except as specified by the Engineer. Materials shall be neatly piled so as to inconvenience as little as possible the public and adjoining property owners until used or otherwise disposed of as specified below.

B. Suitable excavated material may be used on the different parts of the work upon testing and approval.

C. Surplus fill brought to the site by the Contractor shall become the property of the Contractor and shall be removed and disposed of by him/her off the site.

3.12 DISPOSAL AND REPLACING OF ROCK

A. The Contractor shall remove and dispose of all pieces of ledge and boulders which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil areas is to be replaced by approved surplus excavation obtained elsewhere on the work, insofar as it is

available. Any deficiency in the backfill material shall be made up with acceptable material approved by the Engineer.

B. Fragments of ledge and boulders smaller than 50-lb weight may be used in backfilling trenches unless in the opinion of the Engineer the quantity is excessive, in which case he/she may order the removal and disposal of some of this rock. The small pieces of rock used as backfill shall not be placed in trenches until the pipe has at least 2-ft of earth over it. The Contractor shall place these pieces of stone in thin layers alternating them with earth to be sure that all voids between the stones are completely filled with earth to prevent the occurrence of voids and settlement which will result therefrom.

C. Rock may be used in embankment fill only with the approval of the Engineer.

3.13 GRADING

A. Grading in preparation for placing capping layers and appurtenances shall be performed at all places that are indicated on the Drawings, to the lines, grades and elevations shown and otherwise as directed by the Engineer and shall be performed in such a manner that the requirements for formation of embankments can be followed. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the execution or condition of the work.

B. If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

C. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, due to discrepancies on the Drawings, or in order to obtain satisfactory construction.

D. Stones or rock fragments larger than 2-in in their greatest dimensions will not be permitted in the low permeability layer.

E. In cuts, all loose or protruding rocks on the back slopes shall be jarred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings or as directed by the Engineer.

END OF SECTION

SECTION 02270

SEDIMENTATION AND EROSION CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary to perform all installation, maintenance, removal and area cleanup related to sedimentation control work as shown on the Drawings and as specified herein. The work shall include, but not necessarily be limited to; installation of temporary access ways and staging areas, silt fences, straw bales, sediment removal and disposal, device maintenance, removal of temporary devices, and final cleanup.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. Riprap is included in Section 02271.

B. Topsoil and Hydroseeding is included in Section 02930.

C. Waste Relocation is included in Section 13612.

1.03 SUBMITTALS

A. Within 10 days after the Effective Date of the Agreement, submit to the Engineer for approval, technical product literature for all commercial products to be used for sedimentation and erosion control.

1.04 QUALITY ASSURANCE

A. The Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off site areas or into the wetlands via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the Owner will be considered, for regular maintenance of erosion controls.

B. Sedimentation and erosion control measures shall conform to the requirements outlined in the Town of Hamilton Conservation Commission Order of Conditions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Crushed stone for sediment filtration devices, access ways and staging areas shall conform to MassDOT "Standards and Specifications for Highway and Bridges" Section M2.01.3.

B. Silt Fence

1. Wood posts shall be a minimum of 5-ft in length, 2-in by 2-in.

2. Silt fence fabric shall be a woven, polypropylene, ultraviolet resistant material such as Mirafi 100X as manufactured by Mirafi, Inc., Charlotte, NC or equal.

3. Prefabricated commercial silt fence may be substituted for built-in-field fence. Pre-fabricated silt fence shall be "Envirofence" as manufactured by Mirafi Inc., Charlotte, NC or equal.

C. Erosion Control Matting

1. Erosion control matting shall be installed in all seeded drainage swales and ditches and on all slopes greater than 4H:1V, or as directed by the Engineer.

2. Erosion control matting shall be S150, straw blanket as manufactured by North American Green, Evansville, Indiana or equal.

D. Straw bales shall consist of the straw of threshed oats, wheat, barley or rye, securely bound with string or wire at two locations on each bale. Stakes shall be wood, 2-in by 2-in by 4-ft long. Hay bales shall not be used.

E. Straw mulch shall be utilized on all newly graded areas to protect areas against washouts and erosion. Straw mulch shall be comprised of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold or other objectionable material. The straw mulch shall contain at least 50 percent by weight of material to be 10-in or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.

F. Latex acrylic copolymer, such as Soil Sealant with coalescing agent as manufactured by Soil Stabilization Co., Merced, CA or equivalent shall be used as straw mulch tackifier.

G. An asphalt tackifier shall only be used when temperatures are too low to allow the use of a latex acrylic copolymer and only with prior written approval from the Engineer.

H. Polymer floc logs shall be used at the riprap spillway outlet in the stormwater basin if determined necessary by the Engineer during construction.

PART 3 EXECUTION

3.01 INSTALLATION

A. Silt Fence Installation

1. Silt fences shall be positioned as indicated on the Drawings and as necessary to prevent off site movement of sediment produced by construction activities or directed by the Engineer.

2. Dig trench approximately 6-in wide and 8-in deep along proposed fence lines.

3. Drive wood-stakes, 8-ft on center (maximum) at back edge of trenches. Stakes shall be driven 2-ft (minimum) into ground when installed beyond the limit of the cap. Stakes driven

within the footprint of the landfill cap shall be driven no more than half the depth of the cover material placed at that time.

4. Install pre-fabricated silt fence according to manufacturer's instructions.

5. Backfill trench with excavated material and tamp.

B. Straw Bale Installation

1. Bales shall be placed to form temporary water stops, dams, diversions, dikes, berms and for other uses connected with water pollution control; bales will be left in place or disposed of by the Contractor as best suits field conditions and requirements, as directed by the Engineer.

2. On sloping terrain, bales may be used to trap sediment until vegetation has become established. The details of their placement shall be as approved by the Engineer.

3. Bales will be staked in the manner shown on the Drawings. Bales installed on the landfill cap shall be staked in a manner to avoid puncturing the cap.

C. Erosion Control Matting Installation

1. Erosion control matting shall be installed in accordance with the manufacturer's instructions on all slopes and in all drainage swales and ditches as shown on the Drawings and as directed by the Engineer.

2. The area shall be properly prepared, fertilized and seeded before the blanket is installed.

3. When unrolled the netting shall be on top and the fibers in contact with the soil.

4. The mat shall be applied in the direction of water flow, butted snugly at the ends and sides, and stapled in place.

5. Staples shall be made of wire, .091-in in diameter or greater, "U" shaped with 6-in legs on an 1-in crown.

6. Staples shall be driven vertically into the ground, spaced approximately 6-ft apart on each side, and one row of staples down the center alternately spaced from those staples on either side.

D. Staging areas and access ways shall be surfaced with a minimum depth of 4-in of crushed stone.

3.02 MAINTENANCE AND INSPECTIONS

A. Inspections

1. Make a visual inspection of all sedimentation control devices once per week and promptly after every rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to offsite areas, the Contractor shall promptly install additional devices as needed at his/her own expense. Sediment controls in need of maintenance shall be repaired promptly.

B. Device Maintenance

1. Silt Fences

   a. Remove accumulated sediment once it builds up to one-third of the height of the fabric.

   b. Replace damaged fabric, or patch with a 2-ft minimum overlap.

   c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.

2. Straw Bales

   a. Remove accumulated sediment once it builds up to one-third of the height of the bales.

   b. Remove and replace any damaged bales.

   c. Add additional bales as necessary at the direction of the Engineer.

3. Add crushed stone to access ways and staging area as necessary to maintain a firm surface free of ruts and mudholes.

3.03 REMOVAL AND FINAL CLEANUP

A. Once the site has been fully stabilized against erosion (final acceptance of vegetation as defined in Section 02930), remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Regrade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings.

END OF SECTION

SECTION 02271

RIPRAP

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and place riprap and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Earth excavation and backfill is included in Section 02200.

B. Fill materials are included in Section 02200.

PART 2 PRODUCTS

2.01 MATERIALS

A. Riprap used for channel and slope protection shall be hard, durable, angular in shape, resistant to weathering and may be naturally occurring particles or fragments of natural stone. Control of gradation shall be by visible inspection. Rounded stones, boulders, sandstone, or similar soft stone or relatively thin slabs will not be acceptable. Stone shall be free from overburden, spoil, shale and organic material. Each stone shall weigh not less than 50 lbs nor more than 125 lbs and at least 75 percent of the volume shall consist of stones weighing not less than 75 lbs each. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact.

B. Where indicated on the Drawings, a screened gravel base shall be placed and graded to a depth of 12-in to obtain a continuous uninterrupted bed of the required thickness within the required limits. See Section 02200 for screened gravel material. It shall be compacted as specified in Paragraph 3.01 below.

C. Riprap shall be placed and graded off in a manner to ensure that the larger rock fragments are uniformly distributed and that the smaller rock fragments serve to fill the spaces between the larger rock fragments in a manner that will result in a compact mass of stone of the specified thickness. Hand placing will be required only to the extent necessary to secure the results specified above.

D. Riprap shall have a minimum placed thickness of 12-in with individual pieces at the surface having a maximum deviation of plus or minus 2-in.

E. Placing of riprap in layers or by dumping into chutes or by similar methods to cause segregation will not be permitted.

PART 3 EXECUTION

3.01 INSTALLATION

A. The construction methods, compaction equipment, and appurtenances for screened gravel shall be in accordance with Section 405, Gravel Base Course, from the Department of Transportation, Standard Specifications for Highways and Bridges at the Commonwealth of Massachusetts, latest addition and supplements thereto.

B. Place riprap and screened gravel base to the limits and grades shown on the Drawings.

END OF SECTION

SECTION 02575

PAVEMENTS, MARKINGS, AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to furnish and install the bituminous concrete pavements, parking areas, curbing, walkways, as shown on the Drawings and as specified herein.

B. Streets, driveways, parking areas or sidewalk pavements damaged or disturbed by the Contractor's operations shall be repaired, replaced or restored in accordance with the requirements specified herein and as directed for the respective type of pavement replacement and in a manner satisfactory to the Owner.

C. Bituminous concrete pavements and pavement match areas shall be composed of layered thicknesses as specified herein.

1.02 RELATED WORK

A. Site Preparation is included in Section 02100.

B. Earthwork is included in Section 02200.

C. Topsoil, Loam, Seeding are included in Section 02930.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings showing dimensions layouts and details of construction and accessories required.

B. Product information for aggregate materials, asphaltic concrete mix design, and prime and tack coats. Minimum information shall include source of aggregates and asphalt, gradation, unit weight of mix design, gradation, air void content, and other test results needed for comparison with Local Building Code and field testing by Engineer.

1.04 REFERENCE STANDARDS

A. Except as otherwise specified herein, the material and construction shall be in accordance with the MassHighway Standard Specifications for Highways and Bridges of the Commonwealth of Massachusetts, latest edition, including all addenda (MHSSHB).

B. American Society for Testing and Materials (ASTM)

1. ASTM D5581 - Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.

C. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M144 - Standard Specification for Calcium Chloride

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 PAVEMENT MATERIALS

A. Bituminous Concrete Paving shall be installed in the following layers:

1. 2-in top course; 2-in binder, 8-in processed gravel course for:

- Alternative pavement cap

B. Calcium chloride shall meet AASHTO M-144 and shall be spread wherever directed by Engineer to allay dust conditions. The Engineer may direct the Contractor to employ sprinkling of water in lieu of calcium chloride for dust control.

C. Material for processed gravel and crushed stone base course shall be as specified in Section 02200.

D. Bituminous concrete paving shall be Class I, as specified in Sections 460 and M3.11.00 of MHSSHB.

E. Asphalt - Tack coat shall consist of either emulsified asphalt, grade RS-1 conforming to Section M3.03.0, or cutback asphalt, grade RC-70 or RC-250, conforming to Section M3.02.0 of MHSSHB. The contact surfaces of castings and other structures shall be painted with a tack coat.

F. All pavement thicknesses referred to herein are compacted thickness. Place sufficient mix to ensure that the specified thickness of pavement occurs wherever called for. Pavement layers shall be placed and compacted by steel rollers of sufficient weight to thoroughly compact pavement material without damaging existing underlying materials.

PART 3 EXECUTION

3.01 PAVING - GENERAL

A. Bituminous concrete pavement shall be mixed, delivered and installed in accordance with Sections 460 and M3.11.00 of MHSSHB.

B. The subgrade shall be brought to the required grades and cross sections by excavating, filling, blading and compacting as specified

C. The binder course shall be placed as soon as possible after the gravel subbase has been prepared, shaped and compacted.

D. The binder course shall be placed and compacted by steel-wheeled rollers of sufficient weight to thoroughly compact the bituminous concrete. Where necessary, the new pavement shall be rolled smooth and even with the existing pavement.

E. Maintain pavement under this Contract during the guarantee period of 1 year and promptly (within 3 days of notice given by Engineer or Owner) refill and repave areas which have settled or are otherwise unsatisfactory for traffic.

F. All pavement thicknesses referred to herein are compacted thicknesses. Place sufficient mix to ensure that the specified thickness of pavement occurs wherever called for.

G. When required, remove existing pavement by saw, pneumatic hammer or wheel, cutting edges of trenches to be repaved as directed by the Engineer. After pipe laying, backfilling and compaction operations are completed satisfactorily and after the gravel subbase is shaped and compacted, place the type of pavement as directed by the Engineer.

H. Hose clean all road surfaces after backfilling and before any surfacing, but in no case will pavement be placed until the gravel base is dry and compacted to at least 95 percent maximum density at optimum moisture content.

I. All manhole frames and utility boxes are to be set at finish grade. At no time shall the manhole frames be allowed to protrude above the surface of the finish grade.

J. Furnish and spread calcium chloride on disturbed surfaces to allay dust conditions as directed by the Engineer and in accordance with the requirements established by Section 01110.

K. The contact surfaces of castings and other structures shall be painted with a tack coat.

L. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers weighing not less than 240 lbs/in width of tread.

M. Final compaction of the surface shall be accomplished by rollers weighing not less than 285 lbs/in width of tread. Along curbs, structures and all places not accessible with a roller, the mixture shall be thoroughly compacted with tampers. Such tampers shall not weigh less than 25 lbs and shall have a tamping face of not more than 50 sq in. The surface of the mixture after compaction shall be smooth and true to the established line and grade.

N. When the air temperature falls below 50 degrees F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials and placing and compacting the mixtures.

O. No mixtures shall be placed when the air temperature is below 40 degrees F, nor when the material on which the mixtures are to be placed contains frost or has a surface temperature the Engineer considers too low.

P. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Engineer.

Q. All pavements shall be laid over a prepared subbase, thoroughly compacted and shaped to the required grade and cross Section as shown on the Drawings or approved by the Engineer. Cross section of all handicap accessible pedestrian pathways and sidewalks shall not exceed 2 percent cross slope or 5 percent longitudinal slope.

R. No paving is to be placed after November 15 or before April 1 unless permission to do so is granted by the Owner.

S. Contractor shall ensure that pavement is placed to the edge of waste and/or beyond as shown on the Drawings, as the pavement is acting as an alternative landfill cap.

T. Where new concrete sidewalks or bituminous concrete patches or access roads meet existing pavements, Contractor shall create straight, clean and smooth transitions between pavements by saw cutting and patching existing pavements where necessary and matching finish grades of all pavements.

U. Finish grade of all pavements shall have positive drainage. Ponds, puddles, depressed areas or grades creating bird baths deeper than 1/8-in will not be accepted, and at the request of the Engineer, such pavements shall be removed and reinstalled at the expense of the Contractor.

V. Contractor shall finish all edges with a neat, continuous tamped edge.

W. After completion, the bituminous concrete areas shall conform to the thickness shown on the Drawings, smooth and even and of a dense and uniform structure. When tested with a 16-ft straightedge placed parallel to the straight sections of the centerline of the pavements, there shall be no deviation from a true surface in excess of 1/4-in.

3.02 TRENCH PAVEMENT RESTORATION

A. Place 2-1/2-in binder course over trenches cut in existing paved areas no later than 1 week after the trench has been backfilled.

3.03 PAVEMENT SETTLEMENT

A. If points of settlement or holes appear in the pavement, repair the same within 3 days of notification by the Engineer or Owner. If after due notice, if failure to make the repairs is evident, the work will be done by the Owner and the total cost of such repairs will be charged to the Contractor.

3.04 GUARANTEE/WARRANTY

A. All pavement materials placed shall be maintained over the winter. During this period, all areas which have settled or are unsatisfactory for traffic shall be refilled and replaced at the direction of the Owner.

B. All pavements, joint and crack filler, pavement sealer and granite work shall be guaranteed against defects in workmanship or quality for a period of one year after final acceptance. Contractor shall repair at no additional cost to the Owner.

END OF SECTION

SECTION 02647

LANDFILL GAS VENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install 6 landfill gas vents complete, as shown on the Drawings and as specified herein.

1. Equipment and tools shall be steam cleaned prior to being mobilized onto the site and before leaving the site.

2. Meet all health and safety requirements prior to the beginning work and for the duration of the project.

B. The vents shall be installed at the approximate locations shown on the Drawings. Exact vent locations shall be field verified in the presence of the Engineer.

C. These Specifications are intended to give a general description of what is required, but do not cover all variations that may occur during vent construction. The Specifications are intended to cover the successful completion of the vents as herein specified, whether every detail is specifically mentioned or not.

1.02 RELATED WORK

A. Granular materials are included in Section 02200.

1.03 SUBMITTALS

A. Within 30 days following the Effective Date of the Agreement, submit the following information in accordance with Section 01300:

1. A complete list of construction material and supplies as specified herein, including the name of the manufacturer, for the items listed below.

   a. Non-perforated pipe

   b. Perforated pipe

   c. Caps, collars, and tees

   d. Stone

   e. Bentonite

2. Material samples of the washed gravel.

3. Health and Safety Plan.

B. During all gas vent installation, a daily detailed report shall be maintained and submitted as requested by the Engineer including, but not necessarily limited to the presence of groundwater and/or leachate. The report shall give a complete description of all subsurface material encountered, number of feet excavated, number of hours on the job, shutdown due to breakdown, feet of screen and casing set and other pertinent data requested by the Engineer.

C. During installation of each vent, maintain a complete log setting forth the following:

1. The reference point of all depth measurements.

2. The depth of which each change of material occurs.

3. The identification of the material.

4. The depth of interval of the material.

5. The results of work space monitoring requiring by the Health and Safety Plan.

6. Other pertinent data requested by the Engineer.

D. Upon completion of each gas vent, submit to the Engineer a report to include the following:

1. The name and location of the job.

2. The date of the vent installation (start and finish).

3. Gas vent number and coordinates, if known.

4. Surface elevation.

5. Sampling numbers and depths and a description of refuse encountered during installation/excavation.

6. Thickness of similar strata and apparent changes with depth.

7. The location of any lost materials, or tools.

8. The depth, diameter, and description of the gas vent casing and screen.

9. The total depth of the completed gas vent.

10. The nominal hole diameter of the borehole.

11. Amount and size description of washed gravel and bentonite used.

12. The amount of grout (number of bags) used.

13. Other pertinent data requested by the Engineer.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.

2. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 SITE DESCRIPTION

A. The locations of the gas vents are shown on the Drawings. The gas vents shall be installed in the landfill which may contain hazardous or toxic vapors. Possible hazardous vapors that could be released during trenching and drilling operations include, but are not limited to the following: methane, carbon dioxide, carbon monoxide, hydrogen sulfide, polyvinyl chloride, toluene, and benzene.

B. The landfill may be undergoing continuous settling and compaction due to the various subsurface waste conditions typical of a municipal solid waste landfill.

C. The Contractor shall be responsible for providing electrical generating equipment, if needed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. All parts and materials shall be properly protected so that no damage, deterioration, or contamination shall occur from time of shipment until installation is completed.

B. If in the opinion of the Engineer, parts and materials are damaged, deteriorated, or contaminated before acceptance of the gas vent, the material and/or the gas vent will be rejected. Replace the labor, parts, and materials at no additional cost to the Owner.

C. Materials shall be stored to ensure preservation of their quality and fitness for work. When deemed necessary, they shall be placed on wooden platforms or other hard clean surfaces and not on the ground. Stored materials shall be located so as to facilitate prompt inspection.

1.07 PROJECT/SITE REQUIREMENTS

A. Typical subsurface conditions to be encountered at the landfill may include sand, sludge, compost, municipal refuse, and obstructions such as large buried items.

B. The Contractor shall be aware that unfavorable subsurface geologic conditions may exist at the site selected for the gas vents such as loss of circulation and collapse of the formation. If in the opinion of the Contractor the encountered subsurface conditions are unfavorable for the installation of an individual gas vent due to composition of the refuse, promptly notify the Engineer verbally and in writing, of such conditions.

C. The information concerning the subsurface conditions and problems of which the Contractor is advised is for the sole purpose of assisting in the preparation of his/her bid. The Owner, Engineer, and their consultants do not guarantee the accuracy and the conditions and concerns stated above. These conditions and concerns may not be indicative of the conditions at the site.

D. In the event subsurface conditions are found to be substantially different from what has been indicated, promptly and before such conditions are disturbed, notify the Engineer verbally and in writing of such conditions.

E. Take necessary precautions to prevent damage to any above- or below-ground existing structures. Notify the Engineer of any damaged underground structures and make repairs or replacements before backfilling.

F. During the progress of construction, it is expected that minor relocations of the work will be necessary. Such relocations shall be made only by direction of the Engineer. If obstructions are encountered during excavation/ vent installation, notify the Engineer verbally and in writing before continuing with the construction in order that the Engineer may make such field revisions as are necessary. If the Contractor shall fail to so notify the Engineer when an obstruction is encountered and shall proceed with the construction despite this interference, he/she shall do so at his/her own risk. The Contractor shall receive no payment for any footage excatated in an abandoned borehole where relocation has not been directed by the Engineer.

1.08 PERMITS

A. Obtain any Federal, State, or local permits required for constructing the gas vents, discharging material from the site, or clearing of the site for work or access.

B. Do not perform any work on the gas vents until these permits are obtained.

C. Furnish separate copies of all permits to the Owner and the Engineer as the permits are received. Copies of all permits shall be furnished to the Engineer ten days prior to vent installation.

1.09 QUALIFICATIONS

A. The Contractor responsible for constructing gas vents shall be licensed in the Commonwealth of Massachusetts, employing only competent workers for the execution of this work and all such work shall be performed under the direct supervision of an experienced operator satisfactory to the Engineer.

B. The Contractor/operator shall be capable of identifying subsurface conditions and maintaining complete and current logs and daily notes for the gas vent completion reports.

C. The Engineer and Owner may make any other investigations deemed necessary to determine the ability of the Contractor to perform the work and the Contractor shall furnish to the Engineer all such information and data for this purpose as the Engineer may request.

D. Complete the work described in accordance with applicable portions of the requirements of the Federal, State, or local authorities as well as per 29 CFR 1910, OSHA Standards for Hazardous Waste site workers.

E. The installation crew shall be trained and experienced as required by OSHA for hazardous waste site workers.

F. Furnish a list of all personnel who will be involved in the project and their corresponding qualifications and experience.

1.10 NOTIFICATION

A. Submit to the Engineer in writing, 10 days prior to start of work, the proposed work schedule, including the following:

1. The starting date of the gas vent construction.

2. The dates and order of gas vent construction.

3. The completion date of gas vent construction.

4. Any anticipated work interruptions of duration greater than 24 hours with exception of weekends and holidays.

B. The Contractor shall notify the Engineer in writing, prior to start of work, the number of equipment and personnel to be used on the project. Any change in the number of equipment and personnel shall require written notification of the Engineer, 48 hours prior to the change.

C. The Contractor shall notify the Engineer 24 hours prior to the start or restart of any vent installation activities.

D. No work shall be performed without completing the notification requirements specified above.

1.11 GAS VENT ACCEPTANCE CRITERIA

A. Each of the new gas vents shall be approved based on the following criteria, in the opinion of the Engineer:

1. The vent is structurally sound in conformance with the Specification.

2. The borehole is excavated plumb and true to line.

B. All caps, pipes, gravel packs, and cap shall be set to the depths shown on the Drawings or as directed by the Engineer.

1.12 HEALTH AND SAFETY PROGRAM

A. The work to be performed at this site involves, but is not necessarily limited to, the following possible conditions and hazards:

1. Typical subsurface conditions at the landfill may include sand, sludge, compost, rock, municipal refuse, and obstructions such as large buried items. Precautions will be necessary to address excavation safety.

2. There is a potential for a health hazard exposure to an explosive atmosphere to occur.

B. Incorporate specific health and safety procedures for gas vent installation into the overall project Health and Safety Plan. The plan shall be consistent with the requirements of the following:

1. OSHA Safety and Health Standards 29 CFR 1910 (General Industry), US Department of Labor, Occupational Safety and Health Administration, 1984. Hereafter referred as "29 CFR 1910." Available by calling 513-533-8236.

2. OSHA Safety and Health Standards 29 CFR 1926/1910 (Construction Industry), US Department of Labor, Occupational Safety and Health Administration, 1985. Hereafter referred to as "CFR 1926/1910."

3. Standard Operating Safety Guidelines, US Environmental Response Branch, Hazardous Response Support Division, Office of Emergency and Remedial Response, November 1984. Hereafter referred to as "EPA Guidelines."

C. The plan shall include but not necessarily be limited to, the following components, as appropriate.

1. Characterization and Evaluation

2. Safe Work Practices

3. Engineering Safeguards

4. Medical Surveillance

5. Environmental and Personnel Monitoring

6. Personnel Protective Equipment

7. Training

8. Standard Operating Procedures

9. Control and Decontamination

10. Emergency and Contingency Planning

11. Logs and Reports

12. Hazard Communication Reports

13. Material Handling and Disposal

14. Sanitation

15. Excavation

D. Determination of the appropriate level of worker safety equipment and procedures shall be the responsibility of the Contractor as a result of initial site survey, review of existing data and continued safety and health monitoring program performed in accordance with the requirements specified herein.

E. The plan shall be approved by signature of a designated representative of the Contracting firm, stating that the plan is in compliance with 29 CFR 1910 and 29 CFR 1926/1910. The signed

plan shall be furnished to the Owner and Engineer prior to commencing site work activities as evidence of compliance.

F. Should the Contractor seek relief from, or substitution for, any portion or provision of the plan, such relief or substitution shall be at the sole risk of the Contractor and shall be preceded by notification of the Engineer in writing. The requested modification shall not be implemented until receipt of notification of change is confirmed in writing by the Engineer.

G. Should the Contractor modify any portion or provision of the plan, notify the Engineer in writing of such modifications.

H. Any disregard for the provision of these Health and Safety requirements shall be deemed just and sufficient cause for termination of the Contract without compromise or prejudice to the rights of the Contractor.

1.13 TRAINING

A. The Contractor shall be required to certify that all his/her personnel performing site activity that may require an upgrade to respiratory protection, have received appropriate safety training in accordance with 29 CFR 1910.134 provided by the Contractor. Documentation of such training shall be submitted to the Engineer before any employees will be allowed to work.

B. Instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to the work environment to control or eliminate any hazards or other exposure to illness or injury.

C. All employees required to enter into a confined or enclosed space shall be instructed as to the nature of the hazards involved, the necessary precautions to be taken and in the use of protective and emergency equipment required. Comply with any specific regulations that apply to work in dangerous or potentially dangerous areas.

D. Additionally, the Contractor shall be responsible for and shall guarantee that, personnel not successfully completing the required training are not permitted to perform work that required upgrade to respiratory protection.

1.14 MEDICAL SURVEILLANCE

A. Persons shall not be assigned to tasks requiring the use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The respirator user's medical status shall be reviewed annually.

1.15 PERSONAL PROTECTIVE EQUIPMENT

A. Furnish all onsite personnel with appropriate personal safety equipment and protective clothing and ensure that all safety equipment and protective clothing is kept clean and well maintained. Protocols formally changing the level of protection shall be described in the health and safety plan. In addition, the following items shall be addressed.

1. All prescription eyeglasses in use on the site shall be safety glasses. Prescription lens inserts shall be provided for full face respirators.

2. Footwear used onsite shall be steel-toed, steel shank safety shoes or boots.

3. A written respiratory protection program addressing site-specific respiratory usage shall be developed and submitted to the Engineer. Programs for respiratory protection shall conform to 29 CFR 1910.134.

4. All onsite personnel shall wear a hard hat when engaging in construction or drilling activities.

5. All personal protective equipment work onsite shall be decontaminated or properly disposed of at the end of the work day.

6. Each respirator shall be individually assigned and not interchanged between workers without cleaning and sanitizing. A procedure for assuring periodic cleaning and maintenance shall be furnished and addressed in the health and safety plan.

1.16 PERSONAL HYGIENE AND DECONTAMINATION

A. A discussion of personnel decontamination protocols to be followed by site workers shall be submitted as part of the health and safety plan. In addition, the following conditions and procedures shall be followed:

1. Smoking and chewing shall be prohibited except in a designated Contractor provided smoking area.

2. Eating and drinking shall be prohibited except in a designated Contractor provided lunch or break area.

3. All outerwear shall be removed prior to entering lunch area or smoking area and prior to cleansing hands.

4. Contractor personnel shall be required to thoroughly cleanse their hands and other exposed areas before entering the smoking or lunch areas.

1.17 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

A. Develop contingency plans including evacuation procedures and routes to places of refuge or safe distances from the danger area, for the following potential emergencies: chemical exposure, personal injury, potential or actual fire or explosion, environmental accident (spill or release). In the event of any emergency, without delay: take diligent action to remove or otherwise minimize the cause of the emergency; alert the Engineer and Owner whatever measures might be necessary to prevent any repetition of the conditions or actions leading to, or resulting in, the emergency.

B. Emergency medical care services shall be prearranged at a nearby medical facility with established emergency routes. The staff at the facility shall be advised of the potential medical emergencies that might result.

C. Establish emergency communications with health and emergency services. The name of this facility, name of contact, emergency routes, and emergency communications arrangement shall be provided in the health and safety plan. In addition furnish the following equipment.

1. At least one first aid kit shall be provided and maintained fully stocked at a first aid station which is in proximity to the work.

2. 2A-10 B:C type dry chemical fire extinguisher shall be provided at the site office.

D. Should any unforeseen or safety-related factor, hazard, or condition become evident during the performance of work at this site, it shall be the Contractor's responsibility to bring such to the attention of the Engineer both verbally and in writing as quickly as possible, for resolution. In the interim, take prudent action to establish and maintain safe working conditions and to safeguard employees, the public and the environment in accordance with the Health and Safety Plan.

E. Should the Contractor seek relief from, or substitution for, any portion or provision of the plan, such relief or substitution shall be requested of the Engineer in writing. The requested modification will not be implemented until authorized in writing by the Engineer.

F. Should the Contractor modify any portion or provision of the plan, notify the Engineer in writing of such modifications.

G. Any disregard for the provision of these Health and Safety requirements shall be deemed just and sufficient cause for termination of the Contract without compromise or prejudice to the rights of the Contractor.

PART 2 PRODUCTS

2.01 PIPE CASING

A. PVC Pipe

1. All gas vent casings shall be new, non-perforated, Schedule 80, flush coupled, square threaded, UV-resistant, PVC pipe in accordance with ASTM D1784 and ASTM D1785 and as manufactured by Celanese Piping Systems, Chemical Division; Cabot Company or equal. Casing shall have nominal diameter as shown on the Drawings.

2. Fittings shall be flush coupled, square threaded, UV-resistant as designated in ASTM, D2467 or D2466, as shown on the Drawings and as designated in ASTM D2464 and shall be compatible with the pipe where installed.

3. Pipe shall be furnished perforated, as shown on the Drawings, in the locations shown. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code and pressure class.

2.02 SLOTTED PIPE

A. Gas Vent Screen

1. The slots shall be cut into the pipe at the factory after manufacture. The slotted pipe shall have six rows of .080 slots on 1/4-in centers along the length of the pipe.

2.03 STONE PACK

A. A stone pack shall be used around the perforated and/or slotted pipe for both the vertical vents and the horizontal gas collectors. The stone pack material shall be washed rounded river rock, or washed crushed granite with a minimum diameter of 1-in and a maximum diameter of 1-1/2-in. The stone pack shall be placed around and below the pipe and will vary in length as dependent on each gas vent's completion. The material should be free of roots, trash, and other deleterious material.

2.04 FILL MATERIAL

A. The fill material shall consist of common fill as specified in Section 02200.

2.05 SAND/BENTONITE MIXTURE

A. Bentonite shall be granular bentonite as manufactured by Federal Bentonite; Baroid Benseal or equal. Bentonite pellets shall not be used as a substitute material. The sand shall be natural, classified as non-contaminated, free of roots, trash and other deleterious material and shall have passed through a No.16 sieve.

B. The sand/bentonite mixture shall be a blend of one part sand to one part granular bentonite, mixed dry and hydrated immediately prior to placement in the annular space. The slump range for sand/bentonite mixture shall be 1-2-in. For each sand/bentonite mixture batch mixed, a slump test shall be performed.

2.06 CAPS

A. The bottom of each gas vent casing shall be fitted with a cap as shown on the Drawings. A 1-in diameter hole shall be drilled through the center of the cap and the cap shall be cemented to the pipe.

PART 3 EXECUTION

3.01 VENT PIPE INSTALLATION

A. The 6-in diameter vent pipe shall be secured approximately 6-in above the bottom of the borehole to allow the stone pack to form beneath the perforations as shown on the Drawings. The perforations shall extend to within 1-ft of the bottom of the vent.

B. Fittings shall be flush coupled and square threaded. The use of cement or glue shall not be permitted.

C. Every effort shall be made on the part of the Contractor to assure pipe plumbness and centralization. The Contractor shall use spacers at the perforated section of the vent to assure the pipe is maintained within the center of the borehole. The Engineer shall approve the spacer design prior to its use.

D. The installation of pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.

3.02 BOREHOLE EXCAVATION

A. A 36 in diameter borehole shall be excavated at each site for installation of a landfill gas vent to a depth as shown on the Drawings.

B. Material removed from this landfill as a result of vent installation shall be disposed at the landfill as directed by Engineer.

3.03 STONE PACK, COMMON FILL, AND SAND/BENTONITE INSTALLATION

A. All gravel pack installation shall be performed in the presence of the Engineer. The stone pack shall be installed in the annular space by a method approved by the Engineer that will avoid bridging. The stone pack shall be installed from the base of the borehole to 1-ft above the perforated portion of the casing.

B. The sand and bentonite mixture shall be installed on top of the common fill, as shown on the Drawing, in the presence of the Engineer. The installation shall be by a method approved by the Engineer. The sand/bentonite mixture shall be placed from the top of the common fill to existing grade with the total depth of 2 feet. The sand and bentonite mixture shall be permitted to dry for at least one hour after installation.

C. All installation of stone pack, fill material, and sand/bentonite shall be performed in the presence of the Engineer.

3.04 GAS VENT ABANDONMENT

A. If the Contractor fails to meet the Gas Vent Acceptance Criteria as stated above, or abandons the gas vent because of loss of tools, casing collapse, or other causes related to vent construction operations, Contractor shall abandon the gas vent. Under these conditions, the Contractor shall receive no payment for time, materials, or work for abandonment and shall receive no compensation for the abandoned gas vent and shall replace the abandoned gas vent at the unit prices bid on Bid Form.

B. Notify the Engineer immediately if any obstruction is encountered during excavation for a gas vent. If directed by the Engineer to abandon a borehole, fill the borehole with common fill, or another gravel approved by the Engineer to a depth which is within 3 ft of the top of the landfill at the site. Fill in remaining upper borehole internal with a sand/bentonite mixture approved by the Engineer.

C. If borehole abandonment is directed by the Engineer, the Contractor shall be paid for waste excavated at the abandoned borehole.

3.05 PROTECTION AND SITE CLEAN-UP

A. At all times during the progress of the site work, use all reasonable precautions to prevent either tampering with the landfill gas vents or the entrance of foreign material.

B. All landfill gas vents shall be protected by the provision of temporary supports or other means of protection approved by the Engineer. The Contractor shall replace any landfill vent that is damaged by construction operations at the Contractor's expense.

C. Immediately upon completion of site work, remove all of the equipment, materials and supplies from the site of the work, remove all surplus materials and debris, fill in all holes or excavations

and restore any disturbed areas to their original condition. Properly dispose of the refuse and material removed from the borehole.

END OF SECTION

SECTION 02901

MISCELLANEOUS WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and perform the miscellaneous work not specified in other sections but obviously necessary for the proper completion of work as shown on the Drawings.

B. When applicable, perform the work in accordance with other sections of this Specification. When no applicable specification exists, perform the work in accordance with the best modern practice and/or as directed by the Engineer.

C. The work of this Section includes, but is not limited to, the following:

1. Cleaning up.

2. Incidental work.

3. Temporary facilities.

1.02 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, a breakdown of the lump sum for miscellaneous work. This breakdown shall be subject to approval by the Engineer and when so approved shall become the basis for determining progress payments and for negotiation of change orders, if required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials required for this Section shall be the same quality of materials that are to be restored. Where possible, re-use existing materials that are removed.

PART 3 EXECUTION

3.01 CLEANING UP

A. Remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations, including haybales and silt fence, and restore the site of the work to a neat and orderly condition.

3.02 INCIDENTAL WORK

A. Do all incidental work not otherwise specified, but obviously necessary to the proper completion of the work as shown on the Drawings and as specified herein.

3.03 TEMPORARY FACILITIES

A. Furnish, install, maintain and remove all temporary facilities required for construction or called for in the specifications.

END OF SECTION

SECTION 02930

TOPSOIL AND HYDROSEEDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required, provide erosion control and place topsoil, seed, finish grade, apply lime and fertilizer, hydraulically apply seed and maintain all seeded areas as shown on the Drawings and as specified herein, including all areas disturbed by construction.

B. Topsoil specified herein shall be used for construction of the landfill cap and stabilization areas as shown on the Drawings.

1.02 RELATED WORK

A. Site preparation including clearing, grubbing and stripping is included in Section 02100.

B. Earthwork including excavation, backfill, fill and grading including the environmental testing of topsoil is included in Section 02200.

C. Sedimentation and erosion control is included in Section 02270.

1.03 SUBMITTALS

A. Samples of all materials shall be submitted for inspection and acceptance upon Engineer's request.

B. Contractor shall be responsible for implementing a Topsoil Sampling Program as specified in Part 2. He/she shall obtain samples of topsoil and submit them for testing to ensure that topsoil conforms to specifications as stated herein. All costs shall be paid for by the Contractor.

C. Engineer may collect samples of topsoil for laboratory analysis and may direct soils with concentrations of contaminants that exceed standards established by the Massachusetts Department of Environmental Protection to be immediately removed from the site.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil shall be fertile, friable, and typical of topsoil of the locality and shall be obtained from a well drained site that is free of flooding. It shall be without admixture of subsoil or slag and free of stones, lumps, plants or their roots, sticks, clay, peat and other extraneous matter and shall not be delivered to the site or used while in a frozen or muddy condition. Topsoil as delivered to the site or stockpiled shall have pH between 5.5 and 7.0. Topsoil shall contain not less than 3 percent nor more than 5 percent organic matter, as determined by loss of ignition of moisture - free samples dried at 100 degrees Celsius. In addition, the soil shall not have been used for corn production two years prior to being used for this project unless the soil is free of the herbicide atrazine.

B. Topsoil shall be classified as a sandy loam using the USDA textural classification system and shall meet the following mechanical analysis:

Sieve Size (Particle Size)	Percentage Finer
1-inch	100
#10	97 to 100
#20	94 to 100
#40	81 to 93
#100	40 to 55
#200	22 to 39
0.002 mm	7 to 18

C. Tests shall be combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition.

D. The organic matter content for topsoil shall be between 8 and 10 percent, or 3 and 5 (depending on cover cross section selected by Contractor) by weight as determined by loss on ignition of moisture free test samples oven dried to a constant weight at a temperature of 100 degrees, Centigrade. To adjust organic matter content, the topsoil may be amended, by the addition of leaf compost or peat moss. Use of organic amendments is acceptable only if random sampling indicates thorough incorporation. The pH value of finished topsoil shall be between pH 5.5 and pH 7.0. It shall contain no toxic materials. Soluble salts shall not be greater than 75 parts per million. Add soil amendments if required at no additional cost to the Owner.

E. Fertilizer shall be commercial mixed free flowing granules or pelleted fertilizer, 10-20-10 (N-P2O5-K2O) grade for lawn and naturalized areas. Fertilizer shall be delivered to the site in original unopened containers each showing the manufacturer's guaranteed analysis conforming to applicable state fertilizer laws. At least 40 percent of the nitrogen in the fertilizer used shall be in slowly available (organic) form.

F. Lime shall be ground limestone containing not less than 85 percent calcium and magnesium carbonates and be ground to such fineness that at least 50 percent shall pass a 100-mesh sieve and at least 90 percent shall pass a 20-mesh sieve.

G. Mulch for hydroseed shall be a specially processed cellulose fiber containing no growth of germination–inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content and not contain in excess of 10 percent moisture colored green dye to visual application location referencing.

G. Seed shall be labeled in accordance with USDA Rules and Regulations under the Federal Seed Act and applicable State seed laws. Seed shall be furnished in sealed bags or containers bearing the date of the last germination, which date shall be within a period of six months prior to commencement of planting operations. Seed shall be from same or previous year's crop; each variety of seed shall have a purity of not less than 85 percent, a percentage of germination not less than 90 percent, shall have a weed content of not more than 1 percent and contain no noxious weeds. The seed mixtures shall consist of seed proportioned by weight as follows:

1. Slope Seed Mix (For all slopes and disturbed areas not otherwise indicated)

Botanical Name	Common Name	Percentage
Festuca arudinacea	Clemfine, Rebel II or Tribute Tall Fescue	40 percent
Festuca rubra	Jamestown Chewings Fescue	10 percent
Festuca longifolia	Resilient Hard Fescue	10 percent
Lolium perenne	Palmer II Perennial Ryegrass	20 percent
Lotus corniculatus	Birds Foot Trefoil (Arvenis Variety)	15 percent
Trifolium repens	White Clover	5 percent

E. The seed shall be furnished and delivered premixed in the proportions specified above. A manufacturer's certificate of compliance to the specified mixes shall be submitted by the manufacturers for each seed type. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed and also the net weight and date of shipment. No seed may be sown until the certificates have been submitted.

F. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.

G. Erosion control matting is specified in Section 02270.

H. Tackifier is specified in Section 02270.

2.02 TOPSOIL SAMPLING PROGRAM

A. Contractor shall submit at least 1 test sample of new topsoil for every source and for every 1000 cubic yards of topsoil delivered for installation. Tests shall be conducted for total organic matter as outlined in paragraph 2.01D above. One test of topsoil for each new source or every 1,000 cubic yards shall be submitted for grain size analysis by ASTM Method D422 to demonstrate compliance with the standards outlined in paragraph 2.01B above. Samples from topsoil delivered shall be taken and submitted to the approved testing laboratory before topsoil has been placed on site. Contractor shall deliver samples to the testing laboratory, have the testing report submitted to the Engineer, and shall pay all costs. Based on the test results, the Contractor shall amend soils to meet the specification and if deemed necessary by the Engineer, amended samples shall be submitted for testing. Contractor shall be responsible for screening topsoil and providing additional amendments and topsoil as required at the Contractor's expense.

B. Reports shall be submitted at least one month before any topsoil is to be placed. Source soil samples shall be tested for Nitrogen supplying capacity, Phosphorus, Potassium, Soluble Salts, pH, grain size distribution, and percent organics. Conformance samples shall be tested for grain size distribution and percent organics every 1,000 cy.

C. Environmental testing of the topsoil shall be conducted in accordance with Section 02200, Paragraph 1.06.

PART 3 EXECUTION

3.01 APPLICATION

A. Topsoil shall be placed to a minimum compacted depth of 6-inches or 12 inches (depending on cap cross section selected) on all areas receiving the final cap. For those disturbed areas of the site

outside the limit of the cap such as the waste relocation area not covered with structures, pavement, or existing woodland, topsoil shall be placed to a minimum compacted depth of 4-inches.

B. For all areas to be seeded:

1. Lime shall be applied at the rate of fifty pounds per 1,000 square feet or as determined by the soil test to bring topsoil pH to a range of 5.5 to 7.0.

2. Fertilizer (10-20-10) with a 50% slow release shall be applied at the rate of twenty pounds per 1,000 square feet or as determined by the soil test.

3. Seed shall be applied at the rate of six pounds per 1,000 square feet.

4. Erosion Control Matting shall be installed on all slopes greater than 4H:1V (4 vertical to 1 horizontal), in grassed swales and in the proposed sedimentation basin, per manufacturer's instructions.

C. If possible, limestone shall be applied two to three months before the application of fertilizer. Limestone may not be mixed with fertilizer for application and shall be applied a minimum of two weeks prior to fertilizer application.

D. After the topsoil is placed and before it is raked to true lines and rolled, limestone shall be spread evenly over the loam surface and thoroughly incorporated by heavy raking to at least one half the depth of topsoil.

E. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the Engineer shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the hydroseedeer.

F. The application of fertilizer may be performed hydraulically in one operation with hydroseeding and fiber mulching. Clean all structures and paved areas of unwanted deposits of the hydroseeded mixture.

3.02 INSTALLATION

A. Previously established grades, as shown on Drawings shall be maintained in a true and even condition.

B. Topsoil shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling. No topsoil shall be spread in water or while frozen or muddy.

C. After topsoil has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All stiff clods, lumps, roots, litter and other foreign material shall be removed from the loamed area and disposed of. The areas shall also be free of smaller stones, in excessive quantities, as determine by the Engineer. The whole surface shall then be rolled with a hand roller weighing not more than 100 pounds per foot of width. During the rolling, all depressions

caused by settlement of rolling shall be filled with additional loam and the surface shall be regraded and rolled until a smooth and even finished grade is created.

D. Seeding, mulching and conditioning shall only be performed during those periods within the seasons which are normal for such work as determined by the weather and locally accepted practice, as approved by the Engineer. Hydroseed only when wind speeds are less than five (5) miles per hour.

E. Schedules for seeding and fertilizing must be submitted to the Engineer for approval prior to the work. Seeding for the base bid work as specified herein shall be accomplished as soon as practicable after installation of topsoil in the stabilization areas. All other seeding shall be accomplished between the period of April 1 to June 1 or August 15 to October 1. Seeding during the period from October 2 to March 31 shall only be undertaken upon approval of the Engineer. Seeding during the period from June 1 to August 14 shall only be performed if irrigation is provided.

F. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, furnish the Engineer with a certified statement as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the hydroseeder. Upon completion of seeding operations, furnish the Engineer with a certified statement on the actual quantity of solution applied.

G. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainageways, carry out seeding and mulching no later than two days after unit or portion of the project has been satisfactorily completed. For the purpose of this project a unit is defined as 10,000 square feet. When protection of newly loamed and graded areas is necessary at a time which is outside of the normal seeding season, protect those areas by what ever means necessary as approved by the Engineer and be responsible for prevention of siltation in the areas beyond the limit of work.

H. Erosion control matting shall be installed on all slopes greater than 4H:1V, on the landfill slopes, sedimentation basin and in all drainage swales and ditches as shown on the Drawings and as directed by the Engineer in accordance with manufacturer's instructions. The area to be covered shall be properly prepared, fertilized and seeded before the mat is applied. When the mat is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. The mats shall be applied in the direction of water flow, butted snugly at the ends and side and stapled. Mats shall be placed a minimum of three rows (of four foot) wide (total 12-ft width) within the drainage swale/ditch and stapled together in accordance with manufacturer's instructions. The staples shall be made of wire, 0.091-in in diameter or greater, "U" shaped with legs 6-in in length and a 1-in crown. The staples shall be driven vertically into the ground, spaced approximately two linear yards apart, on each side and one row in the center alternately spaced between each side. Adjoining shall not be overlapped and shall utilize a common row of staples to attach.

I. When newly graded subgrade areas cannot be topsoiled and seeded because of season or weather conditions and will remain exposed for more than 30 days, protect those areas against erosion and washouts by whatever means necessary such as straw applied with a tar tack or by other measures as approved by the Engineer. Prior to application of topsoil, any such materials applied for

erosion control shall be thoroughly incorporated into the subgrade by discing. Fertilizer shall be applied prior to spreading of topsoil.

J. On slopes in addition to straw mulch and tackifier, provide protection against washouts by an approved method. Any washout which occurs shall be regraded and reseeded at the Contractor's expense until a good turf is established.

3.03 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. Keep all seeded areas watered and mowed and in good condition, reseeding all seeded areas if and when necessary until a good, healthy, uniform growth is established over the entire area seeded and maintain all seeded areas in an approved condition until provisional acceptance.

B. The Engineer will inspect all work for provisional acceptance at the end of the maintenance period, upon the written request received at least ten days before the anticipated date of inspection. The maintenance period shall include a minimum of one mowing prior to provisional acceptance as approved by Engineer.

C. A satisfactory turf will be defined as:

1. No bare spots larger than three square feet.

2. No more than ten percent of total area with bare spots larger than one square foot.

3. Not more than fifteen percent of total area with bare spots larger than 6-in square.

D. After the inspection has occurred but prior to provisional acceptance, a soil test by an approved laboratory shall be performed to determine soil fertilization requirements. Additional fertilizer not to exceed 10 lbs per 1000 sq ft of 20-10-10 (with 50% slow release) shall be applied as directed by the Engineer.

E. Furnish full and complete written instructions for maintenance of the seeded areas to the Owner at the time of provisional acceptance.

F. The inspection by the Engineer will determine whether maintenance shall continue. Contractor shall continue maintenance of entire site until all areas of the site meet the minimum requirements specified above.

G. After all necessary corrective work and clean-up has been completed, and maintenance instructions have been received by the Owner, the Engineer will certify in writing the provisional acceptance of the turf areas. Maintenance of all turf areas shall cease on receipt of provisional acceptance.

3.04 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. All seeded areas shall be guaranteed for not less than one full year from the time of provisional acceptance.

B. At the end of the guarantee period, inspection will be made by the Engineer upon written request submitted at least ten days before the substantial completion. Seeded areas not demonstrating

satisfactory stands as outlined above, as determined by the Engineer, shall be renovated, reseeded and maintained meeting all requirements as specified herein.

C. After all necessary corrective work has been completed, the Engineer shall certify in writing the final acceptance of the seeded areas.

END OF SECTION

SECTION 13612

WASTE EXCAVATION AND RELOCATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, tools and equipment necessary for excavation, handling, placement, and compaction of waste materials to be relocated from Areas 2B and 1A to Area 2 as part of this Work. Waste generally includes municipal solid waste, construction and demolition materials, and cover soils placed to relatively shallow depths.

B. The limits of waste materials to be relocated are approximately indicated in the Contract Plans. Soil boring logs and test pit data is attached as Appendix C. Additional information regarding the location of test pits conducted within the limits of Work is available in a report titled "Hamilton Sanitary Landfill Comprehensive Site Assessment", by SEA Consultants, Inc., Cambridge, MA 02139, and dated November 2008.

1.02 RELATED WORK

A. Safety, Health and Emergency Response Requirements are included in Section 01101

B. Environment Protection Procedures are included in Section 01110.

C. Testing and Testing Laboratory Services is included in Section 01410.

D. Site Preparation is included in Section 02100.

E. Earthwork is included in Section 02200.

F. Erosion and Sedimentation Control is included in Section 02270.

1.03 QUALITY ASSURANCE

A. The Engineer's duties do not include supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Engineer nor any observation and testing by the Engineer shall excuse the Contractor from defects discovered in his Work.

1.04 REGULATORY REQUIREMENTS

A. The Work of this Section shall be performed in accordance with all applicable Federal, State, and local regulations, laws, codes, and ordinances governing the handling, transportation, and disposal of hazardous materials.

1.05 DEFINITIONS

A. Decontamination Water - Water generated by the Contractor in decontaminating procedures of excavation equipment within contaminated areas.

B. Contaminated Soil - Soils or fills determined by analytical results to contain any contaminants in excess of MCP reportable concentrations.

C. Contaminated Groundwater - Groundwater determined by analytical results to contain any contaminants in excess of MCP reportable concentrations.

D. MCP – Massachusetts Contingency Plan, 310 CMR 40.0000

E. Waste Excavation – Excavation to the bottom of waste as determined by visual observation and confirmatory testing results.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all employees and Subcontractor(s) with personal protective equipment and protective clothing consistent with the levels of protection for this Work as indicated in the Contractor's Site Health and Safety Plan.

2.02 FILL MATERIALS

A. The backfill material shall meet the requirements of Section 02200.

B. Notify the Engineer as to the source of the backfill materials. Provide samples and test results as required by Section 02200.

2.03 NUISANCE ODOR SUPPRESSION

A. Contractor will maintain on site an odor suppressant foam for nuisance odor control. Contractor shall provide proposed suppressant information to the Engineer for review.

PART 3 EXECUTION

3.01 GENERAL

A. Perform all waste excavation work in accordance with the Site Health and Safety Plan as described in Section 01101 – Safety, Health and Emergency Response Plan Requirements. Waste material excavation work shall consist of but is not limited to utility trenches, removal of obstructions, trench support systems, pre-trenching, mass excavations, and any incidental soil work. Excavation shall include removal of all trees and shrubs required to remove soils.

B. Conduct test pits prior to start of waste relocation activities to confirm horizontal extent of waste along northwest boundary of Area 2B. Test pits shall be backfilled as soon as desired information has been obtained. Backfilled surfaces shall be stabilized in accordance with approved erosion and sedimentation control plans.

C. Excavate waste to the limits shown on the Drawings. The excavation may also include additional material extending beyond the designated areas as directed by the Engineer, as a result of the test pit findings.

D. Provide all layout field data, including ties, to the Engineer. Maintain all required field controls throughout the performance of the Work. Limits and depth of excavated to be provided to the Engineer by Survey as defined in Section 01046.

E. All site health and safety controls shall be fully established and in operation prior to beginning any waste excavation. Site controls shall include but not be limited to work zones properly barricaded, decontamination facilities, and all support equipment and supplies including personal protective equipment. All site controls shall be reviewed by the Engineer in the field.

3.02 SITE PREPARATION

A. Excavated areas shall be protected from the public and/or trespassers by installation of temporary chain link fence or by way of excavation methods. The excavated area shall be secured at the end of each workday.

3.03 EXCAVATION OF WASTE MATERIALS

A. Work and decontamination procedures in areas containing waste material shall be performed in accordance with standard engineering practices.

B. The excavation may include removing additional soils found to contain contamination as directed by the Engineer based on post excavation sampling and analyses described in Paragraph 3.04 of this Section.

C. Contractor shall use odor suppressant on exposed soil surface if nuisance odors are detected.

3.04 POST-EXCAVATION CONFIRMATORY SOIL TESTING (WASTE EXCAVATION)

A. Waste material excavation shall also include additional soils as directed by the engineer based on post excavation confirmatory sampling and analysis.

B. Post excavation sampling of waste excavation will be conducted within the designated areas as described below:

1. Samples shall be collected from the bottom of the excavation at a minimum rate of four (4) samples per acre. Side wall samples shall be collected at a minimum rate of six (6) samples per acre. Side wall samples shall be composited over the vertical interval from the original surface elevation to the bottom of excavation. Each Additional samples shall be collected as required by the Engineer. Each sample shall be composited from at least 4 individual grab samples.

2. Areas with staining or other indications of potential contamination may require additional sampling/characterization. Collect and analyze additional samples as directed by the Engineer.

C. Collect the soil samples and analyze them for total RCRA 8 metals via Method MCP 6000 series (Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver) and PAHs with target analytes via MCP-EPH-Deluxe series using DEP Presumptive Certainty recommended methods with a 24-hour turnaround time. Laboratory reporting limits must be at least ½ of the respective S-1 standard. The Contractor shall incur all costs associated with post excavation

sampling and analysis and securing and maintaining the open excavation areas. Contractor shall provide the Engineer all test results upon receipt.

D. Confirmatory sampling results shall be compared to the Massachusetts Contingency Plan (MCP) Method 1, S-1 soil standards. Waste excavation shall be considered complete if confirmatory sampling results are below their respective S-1 standard.

E. The Engineer may direct the Contractor to excavate and relocate additional areas and depths of impacted soil from areas based on the analytical results from this sampling.

F. Additional post excavation confirmatory sampling and analysis will be conducted by the Contractor in the areas requiring additional excavation. Additional sampling and analysis will be conducted as described in Paragraphs B, C and D above.

G. Waste relocation areas may not be backfilled until confirmatory sampling results are received, reviewed, and approved by Engineer.

3.05 WASTE RELOCATION

A. Wastes shall be relocated to the Area 2 to the locations and grades shown on the Drawings.

B. Wastes shall be handled, placed, and compacted, in accordance with the Commonwealth of Massachusetts Solid Waste Management Regulations, 310 CMR 19.000: SOLID WASTE MANAGEMENT.

C. Waste relocated to Area 2 shall be graded so as not to exceed 4 horizontal to 1 vertical (4H:1V), or a minimum slope of 5 percent.

D. A minimum of six inches of daily cover shall be applied over all exposed solid waste at the end of each working day or more frequently and/or at greater depth, if necessary, to prevent odors, or blowing litter.

E. A minimum of six inches of uniformly compacted intermediate cover shall be applied on the top and side slopes of any filled areas of the landfill which has not received or will not receive relocated waste for 30 days; or a minimum of one foot of uniformly compacted intermediate cover and hydroseed shall be applied on the top and side slopes of any filled areas of the landfill which has not or will not receive solid waste for six months or longer.

F. Daily and intermediate cover shall consist of soils recovered from the Contract and shall be workable under all weather and operational conditions. The cover materials shall be used to control vectors; the occurrence of nuisance conditions such as odors, dust or litter and be placed in a manner so as to minimize erosion by wind and/or water; maintain a physical separation of the waste from the surface environment; be substantially odor free; consist of materials suitable for carrying out the geotechnical and other functions of the cover material; and be free of substances which would attract vectors and free of large objects which would hinder spreading and compaction or otherwise interfere with the proper functions of cover material.

3.06 EQUIPMENT AND VEHICLE DECONTAMINATION

A. Design and construct a decontamination pad to be used to decontaminate equipment and vehicles exiting from the contaminated soil area. The Contractor shall be responsible for the maintenance

and operation of the decontamination station (decontamination pad and wash down equipment) throughout the duration of the work activities. Provide a collection system for the decontamination pad wash water. Collect all wash water resulting from the decontamination process. At the completion of the project, the Contractor shall dismantle and properly dispose of the decontamination pad and resulting contaminated residuals within the landfill.

B. The minimum design requirements of the decontamination pad are as follows:

1. Pad shall have adequate size to accommodate the width and length of the largest piece of equipment that will be used in the exclusion zone as defined in Section 01101 – Safety, Health and Emergency Response Plan Requirements.

2. The pad shall be constructed of 60-mil HDPE geomembrane material and shall have a minimum 12-in high supported containment berm around the perimeter.

3. Pad shall be sloped to a low point sump to allow for thorough collection of decontamination water.

C. All decontamination water within the decontamination pad shall be collected, pumped to, and contained in an aboveground secure storage tank. Decontamination water shall be disposed off-site. On-site treatment and discharge shall only be allowed following the Engineer's, Owner's, and MADEP review (approval from Engineer and Owner required) of a treatment and testing plan. The Contractor shall have adequate storage facilities to properly contain all decontamination water. Submit a decontamination water collection and disposal plan as part of the Work Plan described in Section 01101.

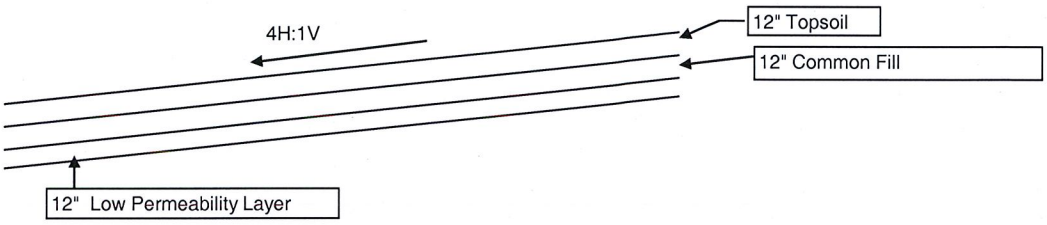
D. The decontamination pad shall be removed and disposed of following the completion of Work. The pad shall either be disposed of with other contaminated material or disposed of as conventional rubble if the Contractor can substantiate, through analytical testing, that the debris is not contaminated. Disposal of the debris shall only be allowed following the Engineer's review of a confirmatory sampling plan. Submit a decontamination pad disposal plan including all proposed sampling and analysis.

END OF SECTION

Appendix D
Soil Loss Calculations

Client:	Town of Hamilton	Job No. :	0644-89096	Computed By:	L. Bugay
Project:	Landfill Closure	Date Checked:	8/31/12	Date:	8/15/2012
Detail:	Area 1 and 2 Slopes	Checked By:	CMK	Page No. :	1 of 2

Universal Soil Loss Calculation



OBJECTIVE:
Ensure the average annual soil loss for this site is less than 2.0 tons/acre/year for all slopes .

METHOD:
Universal soil loss equation A= R x K x L x S x C x P

DEFINITION
A= average annual soil loss in tons/acre/year
R= Regional rainfall and erosivity index
K= Soil erodibility factor in tons/acre
L= Slope length, ft
S= Slope angle
C= Cover management factor
P= Crop support practice factor

Obtain LS factor from equation presented below

SITE SPECIFIC FACTORS:
A= Calculated
R= **114** (see attached map from the USDA RUSLE Guide Document (Attachment A)
K= **0.37** For Topsoil organic content >2%; See Table 2 in
L= **158** Feet Horizontal (From Final Cover Design)
S= **14.04** ° = 4H:1V or 25% (From Final Cover Design)
C= See Tables 4A and 4B in Attachment B
P= See Table 5 in Attachment B

Equation for calculating LS:
LS = [0.065+4.56 SIN(slope) + 65.41 SIN^2(slope)] x [(max. slope length / Constant)^NN]

where:

Constant =	72.5			
Slope (%)=	<1	1<slope<3	3<slope<5	>5
NN =	**0.2**	**0.3**	**0.4**	**0.5**

CALCULATIONS:

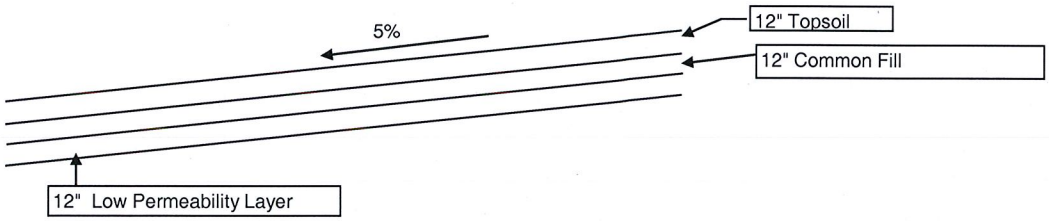
For a 25% (4H:1V) slope with a 158-foot run

	A (tons/acre/year)=	**R x**	**K x**	**LS x**	**C x**	**P**
Bare	**312.6433808**	114	0.37	7.4121238	1	1
Erosion Blanket	**7.034476068**	114	0.37	7.4121238	0.03	0.75
Poor Grass	**2.813790427**	114	0.37	7.4121238	0.018	0.5
Good Grass	**0.390804226**	114	0.37	7.4121238	0.005	0.25

CONCLUSIONS:
1. Under bare ground conditions, excessive soil erosion is expected.
2. Use of erosion control blanket (C=0.03) on side slopes will not reduce soil erosion to acceptable levels until a stand of grass is established.
3. There will be a period between installation of erosion control blanket and establishment of a stand of grass in which the sideslopes of the landfill will be suseptable to severe erosion.
4. Under a good stand of grass, the landfill cover will be at acceptable levels of soil erosion (under 2.0 tons/acre/year).

Client:	Town of Hamilton	Job No. :	0644-89096	Computed By:	L. Bugay
Project:	Landfill Closure	Date Checked:	8/31/12	Date:	8/15/2012
Detail:	Area 1 and 2 Slopes	Checked By:	CMK	Page No. :	2 of 2

Universal Soil Loss Calculation



OBJECTIVE:
Ensure the average annual soil loss for this site is less than 2.0 tons/acre/year for all slopes .

METHOD:
Universal soil loss equation A= R x K x L x S x C x P

DEFINITION
A= average annual soil loss in tons/acre/year
R= Regional rainfall and erosivity index
K= Soil erodibility factor in tons/acre
L= Slope length, ft
S= Slope angle
C= Cover management factor
P= Crop support practice factor

Obtain LS factor from equation presented below

SITE SPECIFIC FACTORS:
A= Calculated

R=	**114**	(see attached map from the USDA RUSLE Guide Document (Attachment A)
K=	**0.37**	For Topsoil organic content >2%; See Table 2 in Attachment B.
L=	**110**	Feet Horizontal (From Final Cover Design)
S=	**2.86**	° = 20H:1V or 5% (From Final Cover Design)
C=		See Tables 4A and 4B in Attachment B
P=		See Table 5 in Attachment B

Equation for calculating LS:
LS = [0.065+4.56 SIN(slope) + 65.41 SIN^2(slope)] x [(max. slope length / Constant)^NN]

where:

Constant =	72.5			
Slope (%)=	<1	1<slope<3	3<slope<5	>5
NN =	**0.2**	**0.3**	**0.4**	**0.5**

CALCULATIONS:

For a 5% (20H:1V) slope with a 110-foot run

	A (tons/acre/year)=	R x	K x	LS x	C x	P
Bare	**23.65899006**	114	0.37	0.5609054	1	1
Erosion Blanket	**0.532327276**	114	0.37	0.5609054	0.03	0.75
Poor Grass	**0.212930911**	114	0.37	0.5609054	0.018	0.5
Good Grass	**0.029573738**	114	0.37	0.5609054	0.005	0.25

CONCLUSIONS:
1. Under bare ground conditions, excessive soil erosion is expected.
2. No erosion control blanket (C=0.03) is proposed on 5% slope areas.
3. There will be a period between installation of erosion control blanket and establishment of a stand of grass in which the sideslopes of the landfill will be suseptable to erosion.
4. Under poor and good stands of grass the landfill cover will be at acceptable levels of soil erosion (under 2.0 tons/acre/year).

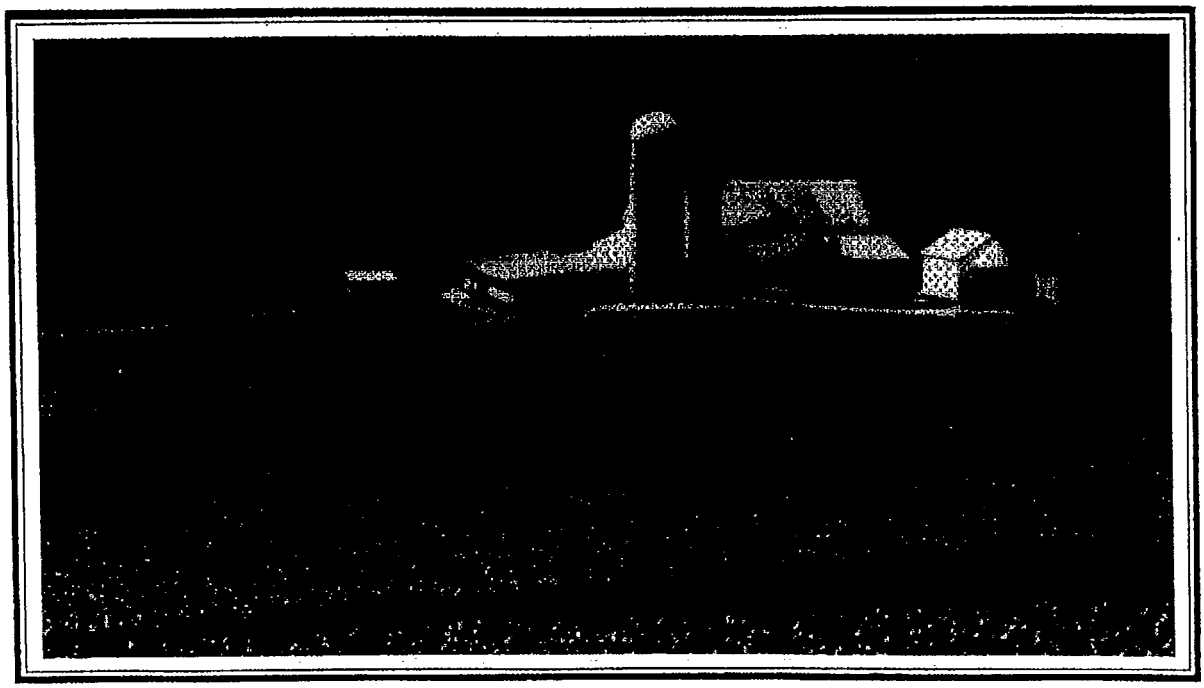
Soil Loss Equation
Attachment A

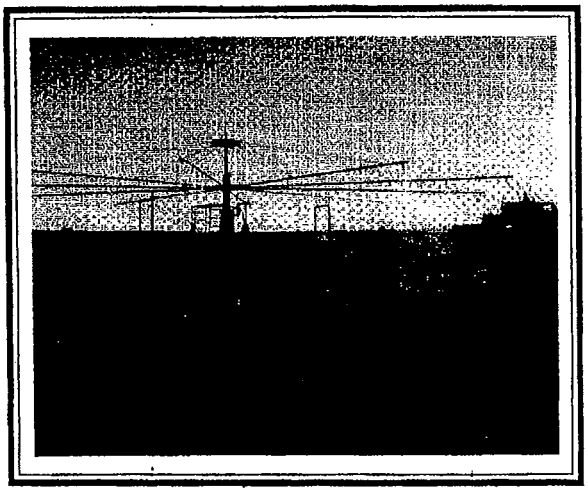
United States Department of Agriculture

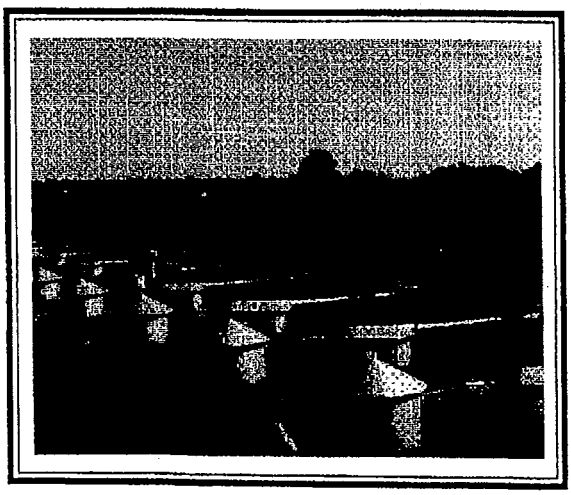
Agricultural Research Service

Agriculture Handbook Number 703

Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE)







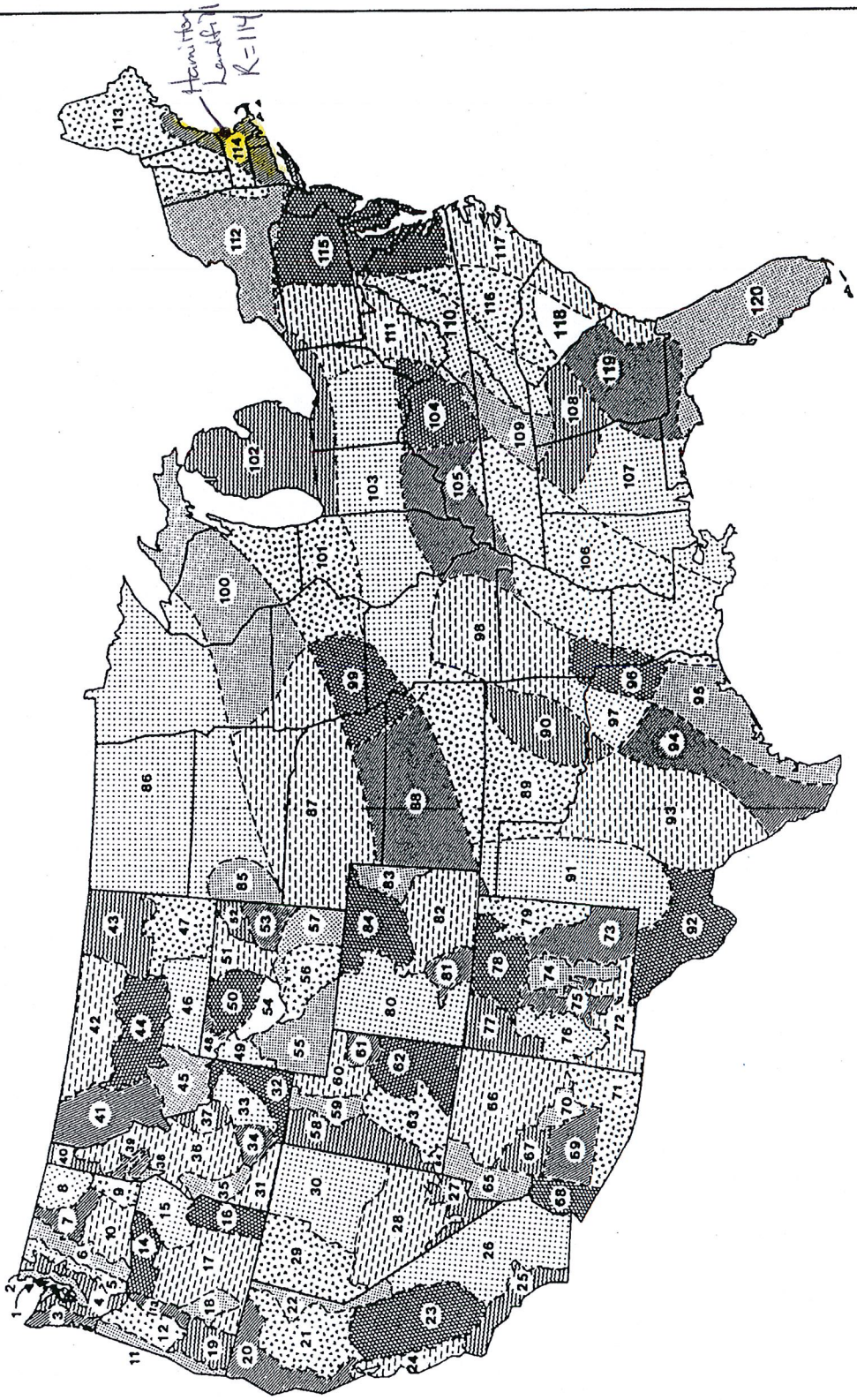


Figure 2-7. EI distribution zones for contiguous United States

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Soil Loss Equation
Attachment B

FACTSHEET

AGRICULTURAL ENGINEERING

ORDER NO. 00-001

MAY 2000

AGDEX 572/751

Ontario Ministry of Agriculture, Food and Rural Affairs

UNIVERSAL SOIL LOSS EQUATION (USLE)

R. P. Stone and D. Hilborn

Background

The Universal Soil Loss Equation (USLE) predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, crop system and management practices. USLE only predicts the amount of soil loss that results from sheet or rill erosion on a single slope and does not account for additional soil losses that might occur from gully, wind or tillage erosion. This erosion model was created for use in selected cropping and management systems, but is also applicable to non-agricultural conditions such as construction sites. The USLE can be used to compare soil losses from a particular field with a specific crop and management system to "tolerable soil loss" rates. Alternative management and crop systems may also be evaluated to determine the adequacy of conservation measures in farm planning.

Five major factors are used to calculate the soil loss for a given site. Each factor is the numerical estimate of a specific condition that affects the severity of soil erosion at a particular location. The erosion values reflected by these factors can vary considerably due to varying weather conditions. Therefore, the values obtained from the USLE more accurately represent long-term averages.

A calculation of soil losses using the USLE may also be done in OMAFRA's Nutrient Management (NMAN 2000 or upgrade) computer program, SOF001. The soil loss value generated from the USLE equation is used to determine the "soil erosion rating value" in the calculation of the Phosphorus Index. See OMAFRA Factsheet *Determining the Phosphorus Index for a Field*, Order No. 98-079.

UNIVERSAL SOIL LOSS EQUATION (USLE)

$$A = R \times K \times LS \times C \times P$$

A represents the potential long term average annual soil loss in tons per acre per year. This is the amount, which is compared to the "tolerable soil loss" limits.

R is the rainfall and runoff factor by geographic location as given in Table 1, *R Factor Data*. The greater the intensity and duration of the rain storm, the higher the erosion potential. Select the R factor from Table 1 based on the county and corresponding station where the calculation is to be made.

K is the soil erodibility factor. (See Table 2, *K Factor Data*). It is the average soil loss in tons/acre per unit area for a particular soil in cultivated, continuous fallow with an arbitrarily selected slope length of 72.6 ft. and slope steepness of 9%. K is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Texture is the principal factor affecting K, but structure, organic matter and permeability also contribute.

LS is the slope length-gradient factor. The LS factor represents a ratio of soil loss under given conditions to that at a site with the "standard" slope steepness of 9% and slope length of 72.6 feet. The steeper and longer the slope, the higher is the risk for erosion. Use either Table 3A, *LS Factor Calculation* or the "Equation for Calculating LS" included in this Factsheet to obtain LS.

C is the crop/vegetation and management factor. It is used to determine the relative effectiveness of soil and crop management systems in terms of preventing soil loss. The C factor is a ratio comparing the soil loss from land under a specific crop and management system to the corresponding loss from continuously fallow and tilled land. The C Factor can be determined by selecting the crop type and tillage method (Table 4A, *Crop Type Factor* and Table 4*B,Tillage Method Factor* respectively) that corresponds to the field and then multiplying these factors together.

The C factor resulting from this calculation is a generalized C factor value for a specific crop that does not account for crop rotations or climate and annual rainfall distribution for the different agricultural regions of the country. This generalized C factor, however, provides relative numbers for the different cropping and tillage systems; thereby helping you weigh the merits of each system.

P is the support practice factor. It reflects the effects of practices that will reduce the amount and rate of the water runoff and thus reduce the amount of erosion. The P factor represents the ratio of soil loss by a support practice to that of straight-row farming up and down the slope. The most commonly used supporting cropland practices are cross slope cultivation, contour farming and stripcropping (Table 5, *P Factor Data*).

PROCEDURE FOR USING THE USLE

1. Determine the R Factor. (Table 1)
2. Based on the soil texture determine the K value (Table 2). If there is more than one soil type in a field and the soil textures are not very different, then use the soil type that represents the majority of the field. Repeat for other soil types as necessary.
3. Divide the field into sections of uniform slope gradient and length. Assign an LS value to each section (Table 3A).
4. Choose the crop type factor and tillage method factor for the crop to be grown. Multiply these 2 factors together to obtain the C factor.
5. Select the P factor based on the support practice used (Table 5).
6. Multiply the 5 factors together to obtain the soil loss per acre.

SOIL LOSS TOLERANCE RATES

A tolerable soil loss is the maximum annual amount of soil, which can be removed before the long term natural soil productivity is adversely affected.

The impact of erosion on a given soil type, and hence the tolerance level varies, depending on the type and depth of soil. Generally, soils with deep, uniform, stone free topsoil materials and/or not previously eroded have been assumed to have a higher tolerance limit than soils which are shallow or previously eroded.

Soil loss tolerance rates are included in Table 6, *Soil Loss Tolerance Rates*.

The suggested tolerance level for most soils in Ontario is 3 tons/acre/year or less.

MANAGEMENT STRATEGIES TO REDUCE SOIL LOSSES

Having obtained an estimate of the potential annual soil loss for a field, you may want to consider ways to reduce this loss to a tolerable level. Table 7, *Management Strategies to Reduce Soil Losses*, outlines management strategies to help you reduce soil erosion.

TABLE 1. R Factor Data

Weather Station	County	R Factor
Brantford	Brant	90
Delhi		100
Essex	Essex	110
Fergus	Dufferin, Wellington	120
Glen Allen		130
Guelph		100
Hamilton	Halton, Hamilton-Wentworth	100
Kingston	Frontenac, Lennox & Addington, Prince Edward	90
Kitchener	Waterloo	110
London	Lambton, Middlesex, Oxford	100
Mount Forest	Bruce, Grey, Haliburton, Muskoka, Simcoe	90
Niagara	Niagara	90
Northern Ont.	Algoma, Cochrane, Kenora, Manitoulin, Parry Sound, Rainy River, Sudbury, Thunder Bay, Timiskaming	90
Ottawa	Dundas, Grenville, Glengarry, Lanark, Leeds, Nipissing, Ottawa-Carleton, Prescott, Renfrew, Russell, Stormont	90
Prospect Hill	Huron, Perth	120
Ridgetown	Kent	110
Simcoe	Haldimand / Norfolk	120
St. Catherines		100
St. Thomas	Elgin	90
Toronto	Metro-Toronto, Peel, York	90
Tweed	Durham, Hastings, Northumberland, Peterborough, Victoria	90
Windsor		110

Note: any other counties not in this chart are assumed to have an R Factor of 90.

↳ See Attached Map by USDA for R Value

TABLE 2: K Factor Data

Textural Class	Organic Matter Content		
	Average	Less than 2 %	More than 2 %
Clay	0.22	0.24	0.21
Clay Loam	0.30	0.33	0.28
Coarse Sandy Loam	0.07	—	0.07
Fine Sand	0.08	0.09	0.06
Fine Sandy Loam	0.18	0.22	0.17
Heavy Clay	0.17	0.19	0.15
Loam	0.30	0.34	0.26
Loamy Fine Sand	0.11	0.15	0.09
Loamy Sand	0.04	0.05	0.04
Loamy Very Fine Sand	0.39	0.44	0.25
Sand	0.02	0.03	0.01
Sandy Clay Loam	0.20	—	0.20
Sandy Loam	0.13	0.14	0.12
Silt Loam	0.38	0.41	0.37
Silty Clay	0.26	0.27	0.26
Silty Clay Loam	0.32	0.35	0.30
Very Fine Sand	0.43	0.46	0.37
Very Fine Sandy Loam	0.35	0.41	0.33

TABLE 3A. LS Factor Calculation

Slope Length ft (m)	Slope (%)	LS Factor
100 (31)	10	1.3800
	8	0.9964
	6	0.6742
	5	0.5362
	4	0.4004
	3	0.2965
	2	0.2008
	1	0.1290
	0	0.0693
200 (61)	10	1.9517
	8	1.4092
	6	0.9535
	5	0.7582
	4	0.5283
	3	0.3912
	2	0.2473
	1	0.1588
	0	0.0796
400 (122)	10	2.7602
	8	1.9928
	6	1.3484
	5	1.0723
	4	0.6971
	3	0.5162
	2	0.3044
	1	0.1955
	0	0.0915
800 (244)	10	3.9035
	8	2.8183
	6	1.9070
	5	1.5165
	4	0.9198
	3	0.6811
	2	0.3748
	1	0.2407
	0	0.1051
1600 (488)	10	5.5203
	8	3.9857
	6	2.6969
	5	2.1446
	4	1.2137
	3	0.8987
	2	0.4614
	1	0.2964
	0	0.1207
3200 (975)	10	7.8069
	8	5.6366
	6	3.8140
	5	3.0330
	4	1.6015
	3	1.1858
	2	0.5680
	1	0.3649
	0	0.1386

EQUATION FOR CALCULATION OF LS (IF NOT USING TABLE 3A ABOVE)

$$LS = \left[0.065 + 0.0456(slope) + 0.006541(slope)^2\right] \left(\frac{slope\_length}{const}\right)^{NN}$$

Where:

slope =	slope steepness (%)
slope length =	length of slope (ft.)
constant =	72.5 Imperial or 22.1 metric
NN =	see Table 3B below

TABLE 3B. NN Values

S	< 1	1 ≤ Slope < 3	3 ≤ Slope < 5	≥ 5
NN	0.2	0.3	0.4	0.5

TABLE 4A. Crop Type Factor

Crop Type	Factor
Grain Corn	0.40
Silage Corn, Beans & Canola	0.50
Cereals (Spring & Winter)	0.35
Seasonal Horticultural Crops	0.50
Fruit Trees,	0.10
Hay and Pasture	0.02 – Grass

TABLE 5. P Factor Data

Support Practice	P Factor
Up & Down Slope	1.0 – During Construction
Cross Slope	0.75
Contour farming	0.50
Strip cropping, cross slope	0.37
Strip cropping, contour	0.25 – After Construction

TABLE 4B. Tillage Method Factor

Tillage Method	Factor
Fall Plow	1.0
Spring Plow	0.90 – During Construct.
Mulch Tillage	0.60
Ridge Tillage	0.35
Zone Tillage	0.25
No-Till	0.25 – After Construct.

TABLE 6. Soil Loss Tolerance Rates

Soil Erosion Class	Potential Soil Loss (tons/acre/year)
Very Low (tolerable)	<3
Low	3 – 5
Moderate	5 – 10
High	10 – 15
Severe	>15

TABLE 7. Management Strategies to Reduce Soil Losses

Factor	Management Strategies	Example
R	The R Factor for a field cannot be altered.	—
K	The K Factor for a field cannot be altered.	—
LS	Terraces may be constructed to reduce the slope length resulting in lower soil losses.	Terracing requires additional investment and will cause some inconvenience in farming. Investigate other soil conservation practices first.
C	The selection of crop types and tillage methods that result in the lowest possible C factor will result in less soil erosion.	Consider cropping systems that will provide maximum protection for the soil. Use minimum tillage systems where possible.
P	The selection of a support practice that has the lowest possible factor associated with it will result in lower soil losses.	Use support practices such as cross slope farming that will cause deposition of sediment to occur close to the source.

EXAMPLE: CALCULATION OF SOIL EROSION USING USLE

$$A = R \times K \times LS \times C \times P$$

Rainfall and Runoff Factor (R)

The sample field is in Middlesex County. Therefore the R Factor is obtained in Table 1 from the London weather station.

R Factor = 100

Soil Erodibility Factor (K)

The sample field consists of fine sandy loam soil with an average organic matter content. The K Factor is obtained from Table 2.

K Factor = 0.18

Slope Length-Gradient Factor (LS)

The sample field is 800 feet long with a 6% slope. The LS factor can be obtained directly from Table 3A or may be calculated using the "Equation". The NN value from Table 3B to be used in the "Equation" is 0.5.

LS Factor = 1.91

Crop/Vegetation and Management Factor (C)

The sample field was plowed in the spring and grain corn was planted. The C Factor is obtained from the crop type factor (Table 4A) and the tillage method factor (Table 4B).

Crop Type Factor for grain corn = 0.4
Tillage Method Factor for spring plow = 0.9

C Factor = 0.4 x 0.9 = 0.36

Support Practice Factor (P)

Cross slope farming is used on this sample field. The P Factor was obtained from Table 5.

P Factor = 0.75

Therefore,

A = R x K x LS x C x P
= 100 x 0.18 x 1.91 x 0.36 x 0.75
= 9.28 tons/acre/year

Referring to Table 6 in this Factsheet, you will see that this soil loss rate of 9.28 tons/acre/year is in the moderate range and considerably higher than the "tolerable loss level" of 3 tons/acre/year. To reduce the soil losses for this sample field below 3 tons/acre/year we will make the following changes to the above example.

Change tillage method from "spring plow (0.9)" to "no-till (0.25)"

$\therefore$ C Factor (Revised) = 0.4 x .25 = 0.10

The adjusted annual soil loss value is

A = R x K x LS x C x P
= 100 x 0.18 x 1.91 x 0.10 x 0.75
= 2.58 tons/acre/year

Thus by changing the tillage practice, the average annual predicted soil loss for this field is below the "tolerable soil loss" of 3 tons/acre/ycar.

This Factsheet was written by **Robert P. Stone**, P.Eng., Soil Management Specialist, OMAFRA, Brighton and **Don Hilborn**, P.Eng., Byproduct Management Specialist, OMAFRA, Woodstock. Factsheet information was assembled by **Paul Muller**, University of Western Ontario, Mechanical Engineering Student and reviewed by: **Adam Hayes**, OMAFRA and **Ramesh Rudra**, University of Guelph.

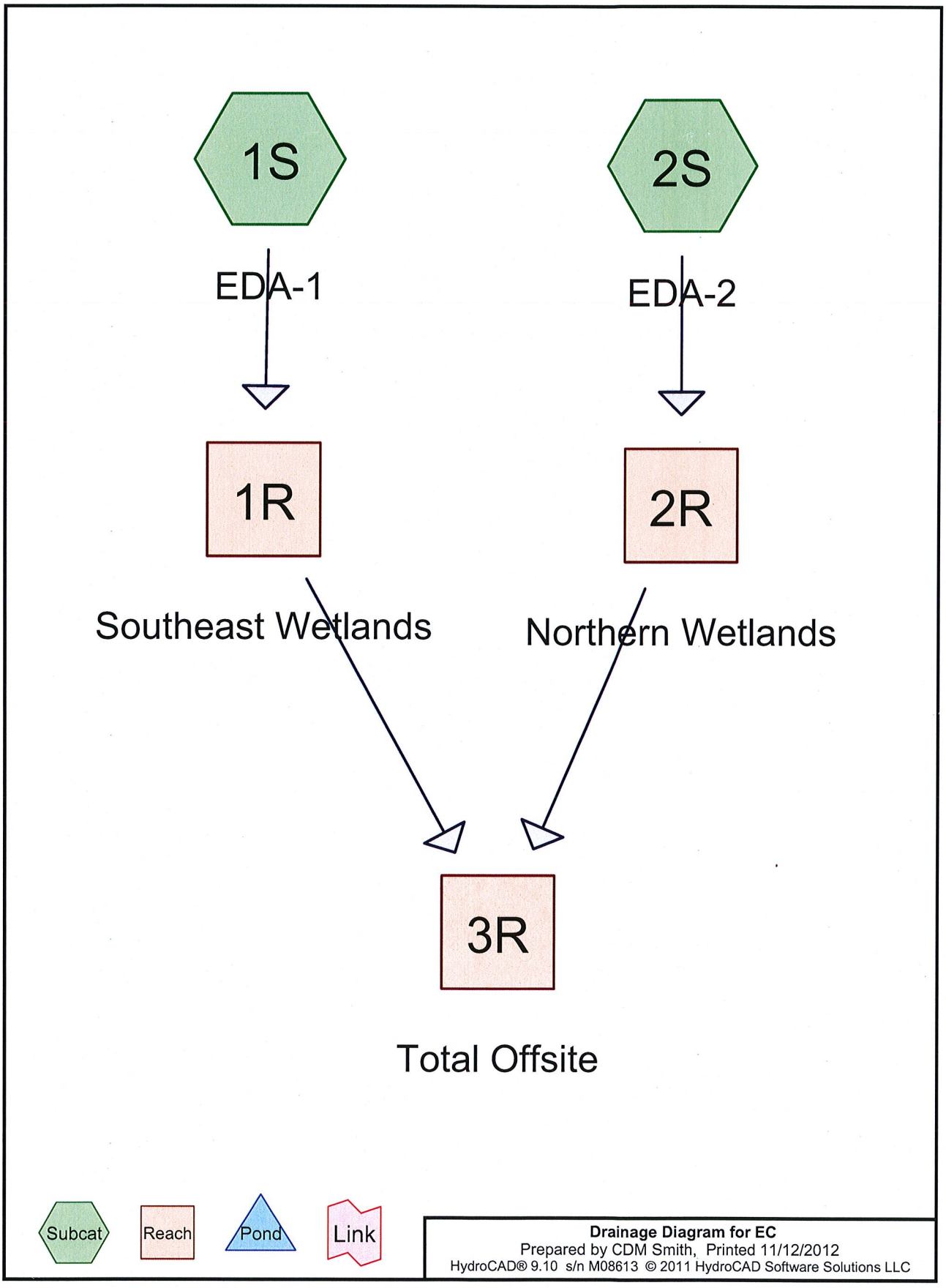
Appendix E

Stormwater Calculations and Drainage Plans

CDM Smith

Pre-Development (Existing) Drainage Calculations

CDM Smith


1S
2S
EDA-1
EDA-2
1R
2R
Southeast Wetlands
Northern Wetlands
3R
Total Offsite
Subcat
Reach
Pond
Link
Drainage Diagram for EC
Prepared by CDM Smith, Printed 11/12/2012
HydroCAD® 9.10 s/n M08613 © 2011 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=396,021 sf 0.00% Impervious Runoff Depth>0.50"
Flow Length=579' Tc=10.0 min CN=62 Runoff=3.16 cfs 0.379 af

Subcatchment 2S: EDA-2 Runoff Area=475,211 sf 0.00% Impervious Runoff Depth>0.67"
Flow Length=1,042' Tc=15.0 min CN=66 Runoff=5.22 cfs 0.605 af

Reach 1R: Southeast Wetlands Inflow=3.16 cfs 0.379 af
Outflow=3.16 cfs 0.379 af

Reach 2R: Northern Wetlands Inflow=5.22 cfs 0.605 af
Outflow=5.22 cfs 0.605 af

Reach 3R: Total Offsite Inflow=8.20 cfs 0.984 af
Outflow=8.20 cfs 0.984 af

Total Runoff Area = 20.001 ac Runoff Volume = 0.984 af Average Runoff Depth = 0.59"
100.00% Pervious = 20.001 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 3.16 cfs @ 12.18 hrs, Volume= 0.379 af, Depth> 0.50"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Yr Rainfall=3.25"

	Area (sf)	CN	Description
*	203,036	58	Wetland Buffer
*	4,350	85	Gravel Access Road
*	85,890	69	Landfill Area
*	102,745	65	Landfill Tree Area
	396,021	62	Weighted Average
	396,021		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 5.22 cfs @ 12.25 hrs, Volume= 0.605 af, Depth> 0.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Yr Rainfall=3.25"

	Area (sf)	CN	Description
*	20,155	85	Gravel Access Road
*	219,535	69	Landfill Area
*	127,625	65	Landfill Tree Area
*	107,896	58	Wetland Buffer
	475,211	66	Weighted Average
	475,211		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	25	0.0320	0.07		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
0.8	263	0.1100	5.34		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	91	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	258	0.0040	1.02		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.2	405	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
15.0	1,042	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 9.091 ac, 0.00% Impervious, Inflow Depth > 0.50" for 2-Yr event
Inflow = 3.16 cfs @ 12.18 hrs, Volume= 0.379 af
Outflow = 3.16 cfs @ 12.18 hrs, Volume= 0.379 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 10.909 ac, 0.00% Impervious, Inflow Depth > 0.67" for 2-Yr event
Inflow = 5.22 cfs @ 12.25 hrs, Volume= 0.605 af
Outflow = 5.22 cfs @ 12.25 hrs, Volume= 0.605 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 0.00% Impervious, Inflow Depth > 0.59" for 2-Yr event
Inflow = 8.20 cfs @ 12.22 hrs, Volume= 0.984 af
Outflow = 8.20 cfs @ 12.22 hrs, Volume= 0.984 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=396,021 sf 0.00% Impervious Runoff Depth>1.31"
Flow Length=579' Tc=10.0 min CN=62 Runoff=11.08 cfs 0.995 af

Subcatchment 2S: EDA-2 Runoff Area=475,211 sf 0.00% Impervious Runoff Depth>1.59"
Flow Length=1,042' Tc=15.0 min CN=66 Runoff=14.57 cfs 1.442 af

Reach 1R: Southeast Wetlands Inflow=11.08 cfs 0.995 af
Outflow=11.08 cfs 0.995 af

Reach 2R: Northern Wetlands Inflow=14.57 cfs 1.442 af
Outflow=14.57 cfs 1.442 af

Reach 3R: Total Offsite Inflow=24.77 cfs 2.437 af
Outflow=24.77 cfs 2.437 af

Total Runoff Area = 20.001 ac Runoff Volume = 2.437 af Average Runoff Depth = 1.46"
100.00% Pervious = 20.001 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 11.08 cfs @ 12.15 hrs, Volume= 0.995 af, Depth> 1.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	203,036	58	Wetland Buffer
*	4,350	85	Gravel Access Road
*	85,890	69	Landfill Area
*	102,745	65	Landfill Tree Area
	396,021	62	Weighted Average
	396,021		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 14.57 cfs @ 12.22 hrs, Volume= 1.442 af, Depth> 1.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	20,155	85	Gravel Access Road
*	219,535	69	Landfill Area
*	127,625	65	Landfill Tree Area
*	107,896	58	Wetland Buffer
	475,211	66	Weighted Average
	475,211		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	25	0.0320	0.07		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
0.8	263	0.1100	5.34		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	91	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	258	0.0040	1.02		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.2	405	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
15.0	1,042	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 9.091 ac, 0.00% Impervious, Inflow Depth > 1.31" for 10-Yr event
Inflow = 11.08 cfs @ 12.15 hrs, Volume= 0.995 af
Outflow = 11.08 cfs @ 12.15 hrs, Volume= 0.995 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 10.909 ac, 0.00% Impervious, Inflow Depth > 1.59" for 10-Yr event
Inflow = 14.57 cfs @ 12.22 hrs, Volume= 1.442 af
Outflow = 14.57 cfs @ 12.22 hrs, Volume= 1.442 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 0.00% Impervious, Inflow Depth > 1.46" for 10-Yr event
Inflow = 24.77 cfs @ 12.19 hrs, Volume= 2.437 af
Outflow = 24.77 cfs @ 12.19 hrs, Volume= 2.437 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=396,021 sf 0.00% Impervious Runoff Depth>2.04"
Flow Length=579' Tc=10.0 min CN=62 Runoff=18.14 cfs 1.544 af

Subcatchment 2S: EDA-2 Runoff Area=475,211 sf 0.00% Impervious Runoff Depth>2.38"
Flow Length=1,042' Tc=15.0 min CN=66 Runoff=22.57 cfs 2.164 af

Reach 1R: Southeast Wetlands Inflow=18.14 cfs 1.544 af
Outflow=18.14 cfs 1.544 af

Reach 2R: Northern Wetlands Inflow=22.57 cfs 2.164 af
Outflow=22.57 cfs 2.164 af

Reach 3R: Total Offsite Inflow=39.31 cfs 3.707 af
Outflow=39.31 cfs 3.707 af

Total Runoff Area = 20.001 ac Runoff Volume = 3.707 af Average Runoff Depth = 2.22"
100.00% Pervious = 20.001 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 18.14 cfs @ 12.15 hrs, Volume= 1.544 af, Depth> 2.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Yr Rainfall=5.93"

	Area (sf)	CN	Description
*	203,036	58	Wetland Buffer
*	4,350	85	Gravel Access Road
*	85,890	69	Landfill Area
*	102,745	65	Landfill Tree Area
	396,021	62	Weighted Average
	396,021		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 22.57 cfs @ 12.22 hrs, Volume= 2.164 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Yr Rainfall=5.93"

	Area (sf)	CN	Description
*	20,155	85	Gravel Access Road
*	219,535	69	Landfill Area
*	127,625	65	Landfill Tree Area
*	107,896	58	Wetland Buffer
	475,211	66	Weighted Average
	475,211		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	25	0.0320	0.07		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
0.8	263	0.1100	5.34		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	91	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	258	0.0040	1.02		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.2	405	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
15.0	1,042	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 9.091 ac, 0.00% Impervious, Inflow Depth > 2.04" for 25-Yr event
Inflow = 18.14 cfs @ 12.15 hrs, Volume= 1.544 af
Outflow = 18.14 cfs @ 12.15 hrs, Volume= 1.544 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 10.909 ac, 0.00% Impervious, Inflow Depth > 2.38" for 25-Yr event
Inflow = 22.57 cfs @ 12.22 hrs, Volume= 2.164 af
Outflow = 22.57 cfs @ 12.22 hrs, Volume= 2.164 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 0.00% Impervious, Inflow Depth > 2.22" for 25-Yr event
Inflow = 39.31 cfs @ 12.18 hrs, Volume= 3.707 af
Outflow = 39.31 cfs @ 12.18 hrs, Volume= 3.707 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=396,021 sf 0.00% Impervious Runoff Depth>3.92"
Flow Length=579' Tc=10.0 min CN=62 Runoff=36.34 cfs 2.972 af

Subcatchment 2S: EDA-2 Runoff Area=475,211 sf 0.00% Impervious Runoff Depth>4.39"
Flow Length=1,042' Tc=15.0 min CN=66 Runoff=42.54 cfs 3.991 af

Reach 1R: Southeast Wetlands Inflow=36.34 cfs 2.972 af
Outflow=36.34 cfs 2.972 af

Reach 2R: Northern Wetlands Inflow=42.54 cfs 3.991 af
Outflow=42.54 cfs 3.991 af

Reach 3R: Total Offsite Inflow=76.19 cfs 6.964 af
Outflow=76.19 cfs 6.964 af

Total Runoff Area = 20.001 ac Runoff Volume = 6.964 af Average Runoff Depth = 4.18"
100.00% Pervious = 20.001 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EDA-1

Runoff = 36.34 cfs @ 12.14 hrs, Volume= 2.972 af, Depth> 3.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Yr Rainfall=8.48"

	Area (sf)	CN	Description
*	203,036	58	Wetland Buffer
*	4,350	85	Gravel Access Road
*	85,890	69	Landfill Area
*	102,745	65	Landfill Tree Area
	396,021	62	Weighted Average
	396,021		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: EDA-2

Runoff = 42.54 cfs @ 12.21 hrs, Volume= 3.991 af, Depth> 4.39"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Yr Rainfall=8.48"

	Area (sf)	CN	Description
*	20,155	85	Gravel Access Road
*	219,535	69	Landfill Area
*	127,625	65	Landfill Tree Area
*	107,896	58	Wetland Buffer
	475,211	66	Weighted Average
	475,211		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	25	0.0320	0.07		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
0.8	263	0.1100	5.34		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	91	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	258	0.0040	1.02		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.2	405	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
15.0	1,042	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 9.091 ac, 0.00% Impervious, Inflow Depth > 3.92" for 100-Yr event
Inflow = 36.34 cfs @ 12.14 hrs, Volume= 2.972 af
Outflow = 36.34 cfs @ 12.14 hrs, Volume= 2.972 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 10.909 ac, 0.00% Impervious, Inflow Depth > 4.39" for 100-Yr event
Inflow = 42.54 cfs @ 12.21 hrs, Volume= 3.991 af
Outflow = 42.54 cfs @ 12.21 hrs, Volume= 3.991 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 0.00% Impervious, Inflow Depth > 4.18" for 100-Yr event
Inflow = 76.19 cfs @ 12.17 hrs, Volume= 6.964 af
Outflow = 76.19 cfs @ 12.17 hrs, Volume= 6.964 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Pre-Development (Existing) Drainage Plan

Figure 1

CHEBACCO ROAD

SITE ENTRANCE

BOULDERS

MW-5

MW-65/D

MATERIALS PILE

BOULDERS

DIRT PILE

COMPOST PILE

SHED

BRUSH PILE

GRAVEL ACCESS ROAD

CONC. BLOCKS

EDA-1

EDA-2

NORTHERN WETLANDS

MW-4S/D

MW-3

MW-1

MW-2

EDGE OF WASTE

EXISTING MONITORING WELL

STONE RET. WALL

SHED

SHED

SHED

SOUTHEAST WETLANDS

POND

HAMILTON

ESSEX

LEGEND

- LANDFILL PROPERTY LINE
- APPROX. LIMIT OF WASTE
- INTERMITTENT STREAM
- 70 — 2007 SURVEY MAJOR CONTOUR (EXISTING 10 FT)
- 2007 SURVEY MINOR CONTOUR (EXISTING 2 FT)
- MW-1 — HAMILTON LANDFILL MONITORING WELL
- 2012 SURVEY MAJOR CONTOUR (EXISTING 10 FT)
- 2012 SURVEY MINOR CONTOUR (EXISTING 2 FT)
- 1-3 1-4 — EDGE OF WETLANDS
- PRE-DEVELOPMENT (EXISTING) DRAINAGE AREA
- DRAINAGE PATH
- EXISTING GRAVEL ROAD

1" = 60'
30 0 60

GENERAL NOTES:

1. AERIAL PHOTOGRAMMETRY CONDUCTED AND COMPILED BY EASTERN TOPOGRAPHICS OF WOLFBORO, NH. PHOTO DATE: APRIL 2, 1989. SOME FEATURES DIGITIZED FROM MASSGIS ORTHOPHOTOS TAKEN APRIL 2001. AN ON THE GROUND FIELD SURVEY WAS CONDUCTED BY WSP SELLS ON JANUARY 17-20, 2012. THE SURVEY BOUNDARY IS SHOWN.
2. THE HORIZONTAL DATUM FOR THE 2012 SURVEY REFERENCES THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM NAD 83 CORS USING RTK GPS.
3. VERTICAL DATUM: NGVD 1929 (THE AERIAL PHOTOGRAMMETRY DATUM IS SUBJECT TO CONFIRMATION).
4. PROPERTY LINES ARE APPROXIMATE AND BASED UPON TOWN OF HAMILTON GIS DATA (2005).
5. LIMIT OF LANDFILL IS BASED UPON TEST PITS ADVANCED BY SEA IN SEPTEMBER 2007.
6. THIS PLAN WAS PREPARED FOR ASSESSMENT PURPOSES ONLY. THE INFORMATION SHOWN WAS COMPILED FROM THE SOURCES NOTED ABOVE.
7. THE WETLAND FLAGS SHOWN HEREON WERE FLAGGED BY CDM SMITH ON DECEMBER 20, 2011; BY HANCOCK ON APRIL 1, 2009 AND BY OTHERS (DATE UNKNOWN).

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: JULY 2013

CDM Smith
50 Hampshire Street
Cambridge, MA 02139
Tel: (617) 452-6000

TOWN OF HAMILTON, MASSACHUSETTS

LANDFILL CLOSURE PROJECT

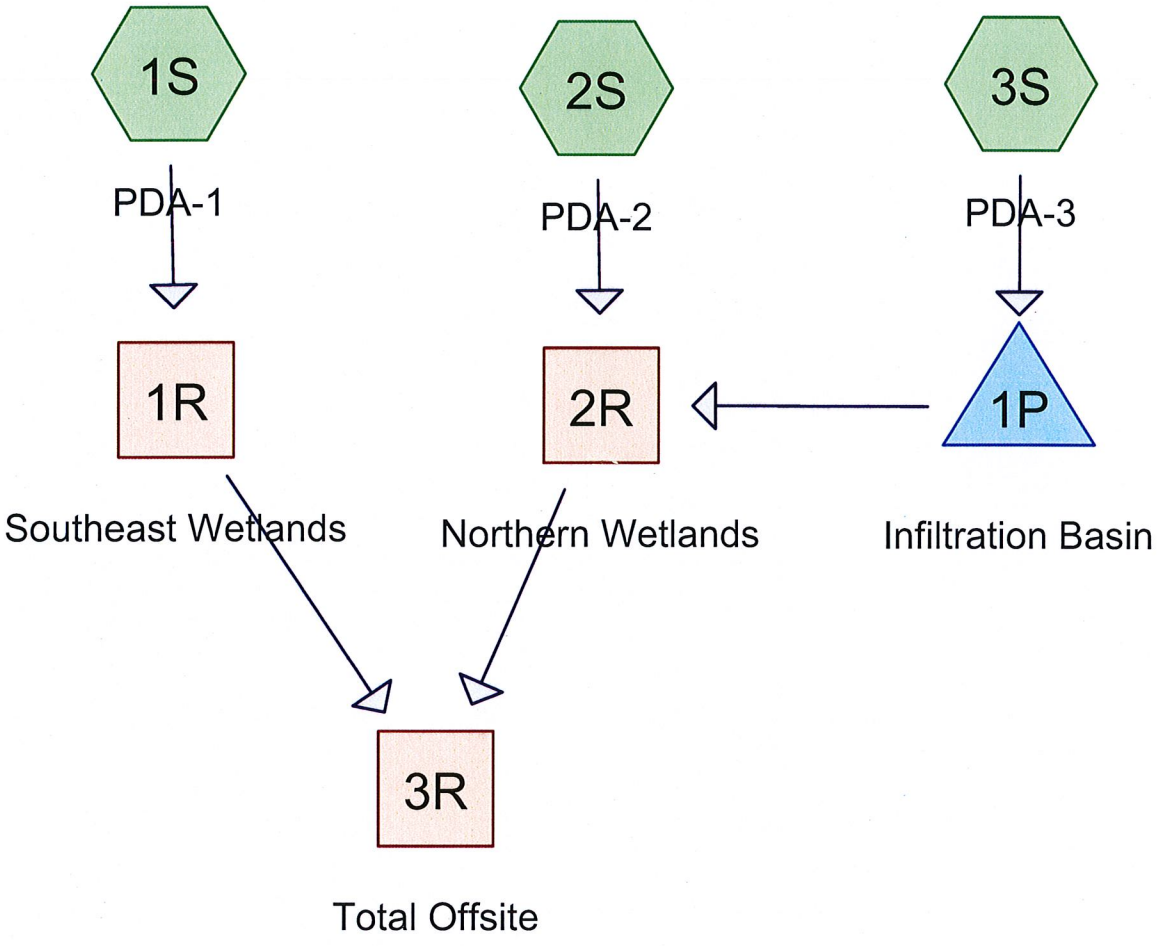
PRE-DEVELOPMENT DRAINAGE AREA PLAN

PROJECT NO. 0644-89096
FILE NAME:

SHEET NO.
FIGURE 1

XREFs: [CDMS_3042_2007 BasePlan For CDM+ AD West Front] Images: []
Last saved by: BKEANE Time: 1/7/2013 4:22:18 PM
pw:\\dscpwpp1:PW_XM1\0644\89096\04 Design Services NM_5%\02 Civil\10 CADD\01 Working\LANDFILL CLOSURE DESIGN\Existing Conditions_Grading_1_1_0907_recovered.dwg

Post-Development (Proposed) Drainage Calculations



Subcat Reach Pond Link

Drainage Diagram for PC
Prepared by CDM Smith, Printed 11/13/2012

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=371,118 sf 0.00% Impervious Runoff Depth>0.58"
Flow Length=579' Tc=10.0 min CN=64 Runoff=3.81 cfs 0.412 af

Subcatchment 2S: PDA-2 Runoff Area=264,420 sf 0.00% Impervious Runoff Depth>0.71"
Flow Length=767' Tc=14.1 min CN=67 Runoff=3.27 cfs 0.359 af

Subcatchment 3S: PDA-3 Runoff Area=235,694 sf 18.84% Impervious Runoff Depth>0.96"
Flow Length=1,369' Tc=16.9 min CN=72 Runoff=4.05 cfs 0.431 af

Reach 1R: Southeast Wetlands Inflow=3.81 cfs 0.412 af
Outflow=3.81 cfs 0.412 af

Reach 2R: Northern Wetlands Inflow=3.27 cfs 0.359 af
Outflow=3.27 cfs 0.359 af

Reach 3R: Total Offsite Inflow=6.93 cfs 0.772 af
Outflow=6.93 cfs 0.772 af

Pond 1P: Infiltration Basin Peak Elev=63.52' Storage=10,485 cf Inflow=4.05 cfs 0.431 af
Discarded=0.29 cfs 0.259 af Primary=0.00 cfs 0.000 af Outflow=0.29 cfs 0.259 af

Total Runoff Area = 20.001 ac Runoff Volume = 1.203 af Average Runoff Depth = 0.72"
94.90% Pervious = 18.981 ac 5.10% Impervious = 1.020 ac

Summary for Subcatchment 1S: PDA-1

Runoff = 3.81 cfs @ 12.17 hrs, Volume= 0.412 af, Depth> 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Yr Rainfall=3.25"

	Area (sf)	CN	Description
*	195,003	58	Wetland Buffer
*	176,115	70	Soil Cap
	371,118	64	Weighted Average
	371,118		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: PDA-2

Runoff = 3.27 cfs @ 12.23 hrs, Volume= 0.359 af, Depth> 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Yr Rainfall=3.25"

	Area (sf)	CN	Description
*	6,448	85	Gravel Access Road
*	180,203	70	Soil Cap
*	43,811	58	Wetland Buffer
*	33,958	61	Grass
	264,420	67	Weighted Average
	264,420		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.1	370	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.3	372	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.1	767	Total			

Summary for Subcatchment 3S: PDA-3

Runoff = 4.05 cfs @ 12.26 hrs, Volume= 0.431 af, Depth> 0.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Yr Rainfall=3.25"

	Area (sf)	CN	Description
*	44,413	98	Pavement Cap
*	84,727	61	Grass
*	106,554	70	Soil Cap
	235,694	72	Weighted Average
	191,281		81.16% Pervious Area
	44,413		18.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.8	391	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2	391	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.7	158	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.5	404	0.0100	2.68	67.01	**Channel Flow,** Area= 25.0 sf Perim= 100.0' r= 0.25' n= 0.022 Earth, clean & straight
16.9	1,369	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 8.520 ac, 0.00% Impervious, Inflow Depth > 0.58" for 2-Yr event
Inflow = 3.81 cfs @ 12.17 hrs, Volume= 0.412 af
Outflow = 3.81 cfs @ 12.17 hrs, Volume= 0.412 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 11.481 ac, 8.88% Impervious, Inflow Depth > 0.38" for 2-Yr event
Inflow = 3.27 cfs @ 12.23 hrs, Volume= 0.359 af
Outflow = 3.27 cfs @ 12.23 hrs, Volume= 0.359 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 5.10% Impervious, Inflow Depth > 0.46" for 2-Yr event
Inflow = 6.93 cfs @ 12.19 hrs, Volume= 0.772 af
Outflow = 6.93 cfs @ 12.19 hrs, Volume= 0.772 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Infiltration Basin

Inflow Area = 5.411 ac, 18.84% Impervious, Inflow Depth > 0.96" for 2-Yr event
Inflow = 4.05 cfs @ 12.26 hrs, Volume= 0.431 af
Outflow = 0.29 cfs @ 16.10 hrs, Volume= 0.259 af, Atten= 93%, Lag= 230.5 min
Discarded = 0.29 cfs @ 16.10 hrs, Volume= 0.259 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 63.52' @ 16.10 hrs Surf.Area= 11,907 sf Storage= 10,485 cf

Plug-Flow detention time= 321.3 min calculated for 0.258 af (60% of inflow)
Center-of-Mass det. time= 201.2 min (1,076.3 - 875.1)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	61,759 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	3,549	241.0	0	0	3,549
63.00	7,658	430.0	5,473	5,473	13,647
64.00	16,732	683.0	11,903	17,377	36,062
65.00	18,810	702.0	17,761	35,137	38,267
66.00	35,290	1,136.0	26,621	61,759	101,752

Device	Routing	Invert	Outlet Devices
#1	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	65.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.29 cfs @ 16.10 hrs HW=63.52' (Free Discharge)
↑**1=Exfiltration** (Controls 0.29 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=62.00' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=371,118 sf 0.00% Impervious Runoff Depth>1.45"
Flow Length=579' Tc=10.0 min CN=64 Runoff=11.75 cfs 1.028 af

Subcatchment 2S: PDA-2 Runoff Area=264,420 sf 0.00% Impervious Runoff Depth>1.66"
Flow Length=767' Tc=14.1 min CN=67 Runoff=8.75 cfs 0.839 af

Subcatchment 3S: PDA-3 Runoff Area=235,694 sf 18.84% Impervious Runoff Depth>2.04"
Flow Length=1,369' Tc=16.9 min CN=72 Runoff=9.20 cfs 0.918 af

Reach 1R: Southeast Wetlands Inflow=11.75 cfs 1.028 af
Outflow=11.75 cfs 1.028 af

Reach 2R: Northern Wetlands Inflow=8.75 cfs 0.839 af
Outflow=8.75 cfs 0.839 af

Reach 3R: Total Offsite Inflow=20.03 cfs 1.868 af
Outflow=20.03 cfs 1.868 af

Pond 1P: Infiltration Basin Peak Elev=64.48' Storage=25,557 cf Inflow=9.20 cfs 0.918 af
Discarded=0.43 cfs 0.425 af Primary=0.00 cfs 0.000 af Outflow=0.43 cfs 0.425 af

Total Runoff Area = 20.001 ac Runoff Volume = 2.786 af Average Runoff Depth = 1.67"
94.90% Pervious = 18.981 ac 5.10% Impervious = 1.020 ac

Summary for Subcatchment 1S: PDA-1

Runoff = 11.75 cfs @ 12.15 hrs, Volume= 1.028 af, Depth> 1.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	195,003	58	Wetland Buffer
*	176,115	70	Soil Cap
	371,118	64	Weighted Average
	371,118		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: PDA-2

Runoff = 8.75 cfs @ 12.21 hrs, Volume= 0.839 af, Depth> 1.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	6,448	85	Gravel Access Road
*	180,203	70	Soil Cap
*	43,811	58	Wetland Buffer
*	33,958	61	Grass
	264,420	67	Weighted Average
	264,420		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.1	370	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.3	372	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.1	767	Total			

Summary for Subcatchment 3S: PDA-3

Runoff = 9.20 cfs @ 12.24 hrs, Volume= 0.918 af, Depth> 2.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	44,413	98	Pavement Cap
*	84,727	61	Grass
*	106,554	70	Soil Cap
	235,694	72	Weighted Average
	191,281		81.16% Pervious Area
	44,413		18.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.8	391	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2	391	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.7	158	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.5	404	0.0100	2.68	67.01	**Channel Flow,** Area= 25.0 sf Perim= 100.0' r= 0.25' n= 0.022 Earth, clean & straight
16.9	1,369	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 8.520 ac, 0.00% Impervious, Inflow Depth > 1.45" for 10-Yr event
Inflow = 11.75 cfs @ 12.15 hrs, Volume= 1.028 af
Outflow = 11.75 cfs @ 12.15 hrs, Volume= 1.028 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 11.481 ac, 8.88% Impervious, Inflow Depth > 0.88" for 10-Yr event
Inflow = 8.75 cfs @ 12.21 hrs, Volume= 0.839 af
Outflow = 8.75 cfs @ 12.21 hrs, Volume= 0.839 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 5.10% Impervious, Inflow Depth > 1.12" for 10-Yr event
Inflow = 20.03 cfs @ 12.17 hrs, Volume= 1.868 af
Outflow = 20.03 cfs @ 12.17 hrs, Volume= 1.868 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Infiltration Basin

Inflow Area = 5.411 ac, 18.84% Impervious, Inflow Depth > 2.04" for 10-Yr event
Inflow = 9.20 cfs @ 12.24 hrs, Volume= 0.918 af
Outflow = 0.43 cfs @ 16.97 hrs, Volume= 0.425 af, Atten= 95%, Lag= 283.9 min
Discarded = 0.43 cfs @ 16.97 hrs, Volume= 0.425 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 64.48' @ 16.97 hrs Surf.Area= 17,704 sf Storage= 25,557 cf

Plug-Flow detention time= 343.5 min calculated for 0.425 af (46% of inflow)
Center-of-Mass det. time= 220.4 min (1,072.8 - 852.4)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	61,759 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	3,549	241.0	0	0	3,549
63.00	7,658	430.0	5,473	5,473	13,647
64.00	16,732	683.0	11,903	17,377	36,062
65.00	18,810	702.0	17,761	35,137	38,267
66.00	35,290	1,136.0	26,621	61,759	101,752

Device	Routing	Invert	Outlet Devices
#1	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	65.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.43 cfs @ 16.97 hrs HW=64.48' (Free Discharge)
↑**1=Exfiltration** (Controls 0.43 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=62.00' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=371,118 sf 0.00% Impervious Runoff Depth>2.21"
Flow Length=579' Tc=10.0 min CN=64 Runoff=18.68 cfs 1.568 af

Subcatchment 2S: PDA-2 Runoff Area=264,420 sf 0.00% Impervious Runoff Depth>2.47"
Flow Length=767' Tc=14.1 min CN=67 Runoff=13.40 cfs 1.249 af

Subcatchment 3S: PDA-3 Runoff Area=235,694 sf 18.84% Impervious Runoff Depth>2.93"
Flow Length=1,369' Tc=16.9 min CN=72 Runoff=13.39 cfs 1.319 af

Reach 1R: Southeast Wetlands Inflow=18.68 cfs 1.568 af
Outflow=18.68 cfs 1.568 af

Reach 2R: Northern Wetlands Inflow=13.40 cfs 1.348 af
Outflow=13.40 cfs 1.348 af

Reach 3R: Total Offsite Inflow=31.34 cfs 2.916 af
Outflow=31.34 cfs 2.916 af

Pond 1P: Infiltration Basin Peak Elev=65.07' Storage=36,555 cf Inflow=13.39 cfs 1.319 af
Discarded=0.48 cfs 0.474 af Primary=0.47 cfs 0.099 af Outflow=0.95 cfs 0.574 af

Total Runoff Area = 20.001 ac Runoff Volume = 4.136 af Average Runoff Depth = 2.48"
94.90% Pervious = 18.981 ac 5.10% Impervious = 1.020 ac

Summary for Subcatchment 1S: PDA-1

Runoff = 18.68 cfs @ 12.15 hrs, Volume= 1.568 af, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Yr Rainfall=5.93"

	Area (sf)	CN	Description
*	195,003	58	Wetland Buffer
*	176,115	70	Soil Cap
	371,118	64	Weighted Average
	371,118		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: PDA-2

Runoff = 13.40 cfs @ 12.20 hrs, Volume= 1.249 af, Depth> 2.47"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Yr Rainfall=5.93"

	Area (sf)	CN	Description
*	6,448	85	Gravel Access Road
*	180,203	70	Soil Cap
*	43,811	58	Wetland Buffer
*	33,958	61	Grass
	264,420	67	Weighted Average
	264,420		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.1	370	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.3	372	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.1	767	Total			

Summary for Subcatchment 3S: PDA-3

Runoff = 13.39 cfs @ 12.23 hrs, Volume= 1.319 af, Depth> 2.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Yr Rainfall=5.93"

	Area (sf)	CN	Description
*	44,413	98	Pavement Cap
*	84,727	61	Grass
*	106,554	70	Soil Cap
	235,694	72	Weighted Average
	191,281		81.16% Pervious Area
	44,413		18.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.8	391	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2	391	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.7	158	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.5	404	0.0100	2.68	67.01	**Channel Flow,** Area= 25.0 sf Perim= 100.0' r= 0.25' n= 0.022 Earth, clean & straight
16.9	1,369	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 8.520 ac, 0.00% Impervious, Inflow Depth > 2.21" for 25-Yr event
Inflow = 18.68 cfs @ 12.15 hrs, Volume= 1.568 af
Outflow = 18.68 cfs @ 12.15 hrs, Volume= 1.568 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 11.481 ac, 8.88% Impervious, Inflow Depth > 1.41" for 25-Yr event
Inflow = 13.40 cfs @ 12.20 hrs, Volume= 1.348 af
Outflow = 13.40 cfs @ 12.20 hrs, Volume= 1.348 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 5.10% Impervious, Inflow Depth > 1.75" for 25-Yr event
Inflow = 31.34 cfs @ 12.17 hrs, Volume= 2.916 af
Outflow = 31.34 cfs @ 12.17 hrs, Volume= 2.916 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Infiltration Basin

Inflow Area = 5.411 ac, 18.84% Impervious, Inflow Depth > 2.93" for 25-Yr event
Inflow = 13.39 cfs @ 12.23 hrs, Volume= 1.319 af
Outflow = 0.95 cfs @ 15.20 hrs, Volume= 0.574 af, Atten= 93%, Lag= 178.2 min
Discarded = 0.48 cfs @ 15.20 hrs, Volume= 0.474 af
Primary = 0.47 cfs @ 15.20 hrs, Volume= 0.099 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 65.07' @ 15.20 hrs Surf.Area= 19,844 sf Storage= 36,555 cf

Plug-Flow detention time= 322.0 min calculated for 0.573 af (43% of inflow)
Center-of-Mass det. time= 201.1 min (1,043.1 - 842.0)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	61,759 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	3,549	241.0	0	0	3,549
63.00	7,658	430.0	5,473	5,473	13,647
64.00	16,732	683.0	11,903	17,377	36,062
65.00	18,810	702.0	17,761	35,137	38,267
66.00	35,290	1,136.0	26,621	61,759	101,752

Device	Routing	Invert	Outlet Devices
#1	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	65.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.48 cfs @ 15.20 hrs HW=65.07' (Free Discharge)
↑**1=Exfiltration** (Controls 0.48 cfs)

Primary OutFlow Max=0.46 cfs @ 15.20 hrs HW=65.07' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.46 cfs @ 0.63 fps)

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=371,118 sf 0.00% Impervious Runoff Depth>4.16"
Flow Length=579' Tc=10.0 min CN=64 Runoff=36.24 cfs 2.953 af

Subcatchment 2S: PDA-2 Runoff Area=264,420 sf 0.00% Impervious Runoff Depth>4.51"
Flow Length=767' Tc=14.1 min CN=67 Runoff=24.92 cfs 2.281 af

Subcatchment 3S: PDA-3 Runoff Area=235,694 sf 18.84% Impervious Runoff Depth>5.10"
Flow Length=1,369' Tc=16.9 min CN=72 Runoff=23.45 cfs 2.300 af

Reach 1R: Southeast Wetlands Inflow=36.24 cfs 2.953 af
Outflow=36.24 cfs 2.953 af

Reach 2R: Northern Wetlands Inflow=24.92 cfs 3.251 af
Outflow=24.92 cfs 3.251 af

Reach 3R: Total Offsite Inflow=59.73 cfs 6.204 af
Outflow=59.73 cfs 6.204 af

Pond 1P: Infiltration Basin Peak Elev=65.46' Storage=45,279 cf Inflow=23.45 cfs 2.300 af
Discarded=0.62 cfs 0.530 af Primary=7.92 cfs 0.970 af Outflow=8.55 cfs 1.500 af

Total Runoff Area = 20.001 ac Runoff Volume = 7.534 af Average Runoff Depth = 4.52"
94.90% Pervious = 18.981 ac 5.10% Impervious = 1.020 ac

Summary for Subcatchment 1S: PDA-1

Runoff = 36.24 cfs @ 12.14 hrs, Volume= 2.953 af, Depth> 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Yr Rainfall=8.48"

	Area (sf)	CN	Description
*	195,003	58	Wetland Buffer
*	176,115	70	Soil Cap
	371,118	64	Weighted Average
	371,118		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	25	0.0200	0.06		**Sheet Flow,** Grass: Bermuda n= 0.410 P2= 3.25"
1.4	261	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	184	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	109	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.0	579	Total			

Summary for Subcatchment 2S: PDA-2

Runoff = 24.92 cfs @ 12.20 hrs, Volume= 2.281 af, Depth> 4.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Yr Rainfall=8.48"

	Area (sf)	CN	Description
*	6,448	85	Gravel Access Road
*	180,203	70	Soil Cap
*	43,811	58	Wetland Buffer
*	33,958	61	Grass
	264,420	67	Weighted Average
	264,420		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.1	370	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.3	372	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.1	767	Total			

Summary for Subcatchment 3S: PDA-3

Runoff = 23.45 cfs @ 12.23 hrs, Volume= 2.300 af, Depth> 5.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Yr Rainfall=8.48"

	Area (sf)	CN	Description
*	44,413	98	Pavement Cap
*	84,727	61	Grass
*	106,554	70	Soil Cap
	235,694	72	Weighted Average
	191,281		81.16% Pervious Area
	44,413		18.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	25	0.0200	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.8	391	0.0600	1.71		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2	391	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.7	158	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.5	404	0.0100	2.68	67.01	**Channel Flow,** Area= 25.0 sf Perim= 100.0' r= 0.25' n= 0.022 Earth, clean & straight
16.9	1,369	Total			

Summary for Reach 1R: Southeast Wetlands

Inflow Area = 8.520 ac, 0.00% Impervious, Inflow Depth > 4.16" for 100-Yr event
Inflow = 36.24 cfs @ 12.14 hrs, Volume= 2.953 af
Outflow = 36.24 cfs @ 12.14 hrs, Volume= 2.953 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: Northern Wetlands

Inflow Area = 11.481 ac, 8.88% Impervious, Inflow Depth > 3.40" for 100-Yr event
Inflow = 24.92 cfs @ 12.20 hrs, Volume= 3.251 af
Outflow = 24.92 cfs @ 12.20 hrs, Volume= 3.251 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Total Offsite

Inflow Area = 20.001 ac, 5.10% Impervious, Inflow Depth > 3.72" for 100-Yr event
Inflow = 59.73 cfs @ 12.16 hrs, Volume= 6.204 af
Outflow = 59.73 cfs @ 12.16 hrs, Volume= 6.204 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Infiltration Basin

Inflow Area = 5.411 ac, 18.84% Impervious, Inflow Depth > 5.10" for 100-Yr event
Inflow = 23.45 cfs @ 12.23 hrs, Volume= 2.300 af
Outflow = 8.55 cfs @ 12.64 hrs, Volume= 1.500 af, Atten= 64%, Lag= 25.0 min
Discarded = 0.62 cfs @ 12.64 hrs, Volume= 0.530 af
Primary = 7.92 cfs @ 12.64 hrs, Volume= 0.970 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 65.46' @ 12.64 hrs Surf.Area= 25,710 sf Storage= 45,279 cf

Plug-Flow detention time= 186.5 min calculated for 1.499 af (65% of inflow)
Center-of-Mass det. time= 87.2 min (913.4 - 826.2)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	61,759 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	3,549	241.0	0	0	3,549
63.00	7,658	430.0	5,473	5,473	13,647
64.00	16,732	683.0	11,903	17,377	36,062
65.00	18,810	702.0	17,761	35,137	38,267
66.00	35,290	1,136.0	26,621	61,759	101,752

Device	Routing	Invert	Outlet Devices
#1	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	65.00'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.62 cfs @ 12.64 hrs HW=65.46' (Free Discharge)
↑**1=Exfiltration** (Controls 0.62 cfs)

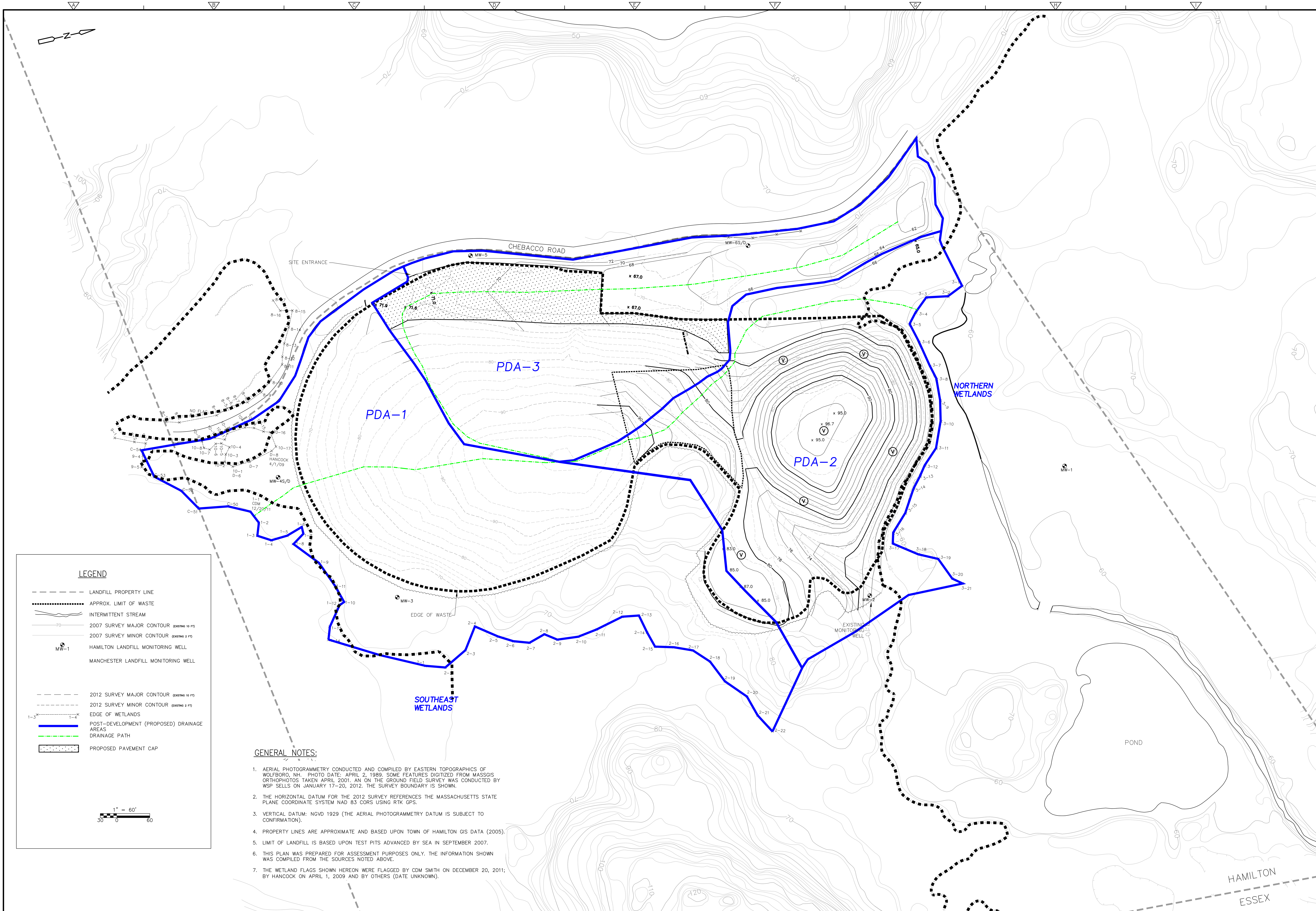
Primary OutFlow Max=7.91 cfs @ 12.64 hrs HW=65.46' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 7.91 cfs @ 1.73 fps)

Hydrograph for Pond 1P: Infiltration Basin

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0	62.00	0.00	0.00	0.00
2.00	0.00	0	62.00	0.00	0.00	0.00
4.00	0.00	0	62.00	0.00	0.00	0.00
6.00	0.00	0	62.00	0.00	0.00	0.00
8.00	0.07	58	62.02	0.03	0.03	0.00
10.00	0.61	1,551	62.37	0.12	0.12	0.00
12.00	**9.61**	**14,447**	**63.81**	**0.35**	**0.35**	**0.00**
14.00	**2.16**	**39,160**	**65.20**	**2.60**	**0.53**	**2.08**
16.00	1.16	37,310	65.11	1.37	0.50	0.87
18.00	0.70	36,262	65.06	0.82	0.48	0.34
20.00	0.55	35,703	65.03	0.61	0.47	0.14
22.00	0.45	35,306	65.01	0.50	0.46	0.04
24.00	0.36	34,865	64.99	0.46	0.46	0.00
26.00	0.00	31,944	64.83	0.45	0.45	0.00
28.00	0.00	28,758	64.65	0.44	0.44	0.00
30.00	0.00	25,643	64.48	0.43	0.43	0.00
32.00	0.00	22,597	64.31	0.42	0.42	0.00
34.00	0.00	19,620	64.13	0.41	0.41	0.00
36.00	0.00	16,718	63.96	0.39	0.39	0.00
38.00	0.00	14,059	63.79	0.35	0.35	0.00
40.00	0.00	11,703	63.61	0.31	0.31	0.00
42.00	0.00	9,630	63.44	0.27	0.27	0.00
44.00	0.00	7,823	63.27	0.23	0.23	0.00
46.00	0.00	6,262	63.10	0.20	0.20	0.00
48.00	0.00	4,923	62.93	0.17	0.17	0.00
50.00	0.00	3,738	62.75	0.15	0.15	0.00
52.00	0.00	2,688	62.58	0.14	0.14	0.00
54.00	0.00	1,764	62.41	0.12	0.12	0.00
56.00	0.00	957	62.24	0.10	0.10	0.00
58.00	0.00	261	62.07	0.09	0.09	0.00
60.00	0.00	4	62.00	0.00	0.00	0.00
62.00	0.00	0	62.00	0.00	0.00	0.00
64.00	0.00	0	62.00	0.00	0.00	0.00
66.00	0.00	0	62.00	0.00	0.00	0.00
68.00	0.00	0	62.00	0.00	0.00	0.00
70.00	0.00	0	62.00	0.00	0.00	0.00
72.00	0.00	0	62.00	0.00	0.00	0.00

Post-Development (Proposed) Drainage Plan

Figure 2



LEGEND

- LANDFILL PROPERTY LINE
- APPROX. LIMIT OF WASTE
- INTERMITTENT STREAM
- 2007 SURVEY MAJOR CONTOUR (EXISTING 10 FT)
- 2007 SURVEY MINOR CONTOUR (EXISTING 2 FT)
- MW-1 HAMILTON LANDFILL MONITORING WELL
- MANCHESTER LANDFILL MONITORING WELL
- 2012 SURVEY MAJOR CONTOUR (EXISTING 10 FT)
- 2012 SURVEY MINOR CONTOUR (EXISTING 2 FT)
- EDGE OF WETLANDS
- POST-DEVELOPMENT (PROPOSED) DRAINAGE AREAS
- DRAINAGE PATH
- PROPOSED PAVEMENT CAP

GENERAL NOTES:

1. AERIAL PHOTOGRAMMETRY CONDUCTED AND COMPILED BY EASTERN TOPOGRAPHICS OF WOLFBORO, NH. PHOTO DATE: APRIL 2, 1989. SOME FEATURES DIGITIZED FROM MASSGIS ORTHOPHOTOS TAKEN APRIL 2001. AN ON THE GROUND FIELD SURVEY WAS CONDUCTED BY WSP SELLS ON JANUARY 17–20, 2012. THE SURVEY BOUNDARY IS SHOWN.
2. THE HORIZONTAL DATUM FOR THE 2012 SURVEY REFERENCES THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM NAD 83 CORS USING RTK GPS.
3. VERTICAL DATUM: NGVD 1929 (THE AERIAL PHOTOGRAMMETRY DATUM IS SUBJECT TO CONFIRMATION).
4. PROPERTY LINES ARE APPROXIMATE AND BASED UPON TOWN OF HAMILTON GIS DATA (2005).
5. LIMIT OF LANDFILL IS BASED UPON TEST PITS ADVANCED BY SEA IN SEPTEMBER 2007.
6. THIS PLAN WAS PREPARED FOR ASSESSMENT PURPOSES ONLY. THE INFORMATION SHOWN WAS COMPILED FROM THE SOURCES NOTED ABOVE.
7. THE WETLAND FLAGS SHOWN HEREON WERE FLAGGED BY CDM SMITH ON DECEMBER 20, 2011; BY HANCOCK ON APRIL 1, 2009 AND BY OTHERS (DATE UNKNOWN).

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: JULY 2013

CDM Smith
50 Hampshire Street
Cambridge, MA 02139
Tel: (617) 452-6000

TOWN OF HAMILTON, MASSACHUSETTS

LANDFILL CLOSURE PROJECT

POST-DEVELOPMENT DRAINAGE AREA PLAN

PROJECT NO. 0644-89096
FILE NAME:
SHEET NO.
FIGURE 2

CDM Smith

cdmsmith.com