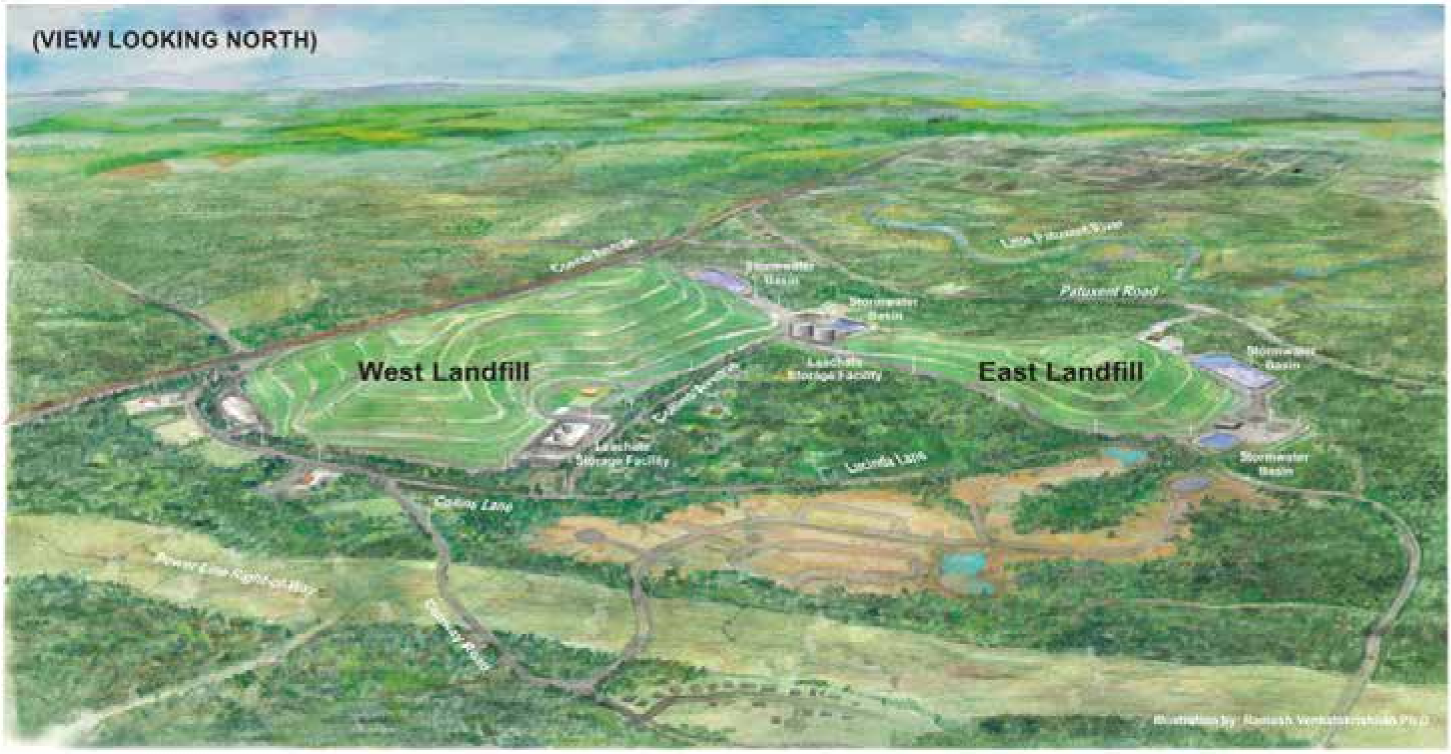
REVISED
PHASE III PERMIT APPLICATION
FOR
CHESAPEAKE TERRACE RUBBLE LANDFILL
ANNE ARUNDEL COUNTY, MARYLAND

VOLUME 1 OF 3



PREPARED FOR:

National Waste Managers, Inc.
2900 Linden Lane
Silver Spring, Maryland 20910

PREPARED BY:

ADVANCED GeoServices
a Montrose Environmental Group company

1055 Andrew Drive, Suite A
West Chester, Pennsylvania 19380

JULY, 2020

PROJECT NO. 2018-3854 **REVISED JANUARY 14, 2022**

PROFESSIONAL ENGINEER'S CERTIFICATION

I hereby certify that these documents entitled *"Revised Phase III Permit Application for Chesapeake Terrace Rubble Landfill, Anne Arundel County, Maryland"* Revised January 14, 2022, were prepared by me, or under my direct supervision, and that I am a duly licensed professional engineer under the laws of the State of Maryland, License No. 21681, Expiration Date: August 11, 2023.

PAUL GERARD STRATMAN
21681

1/14/22
Paul G. Stratman, P.E.
January 14, 2022

PHASE III PERMIT APPLICATION
CHESAPEAKE TERRACE RUBBLE LANDFILL
ANNE ARUNDEL COUNTY, MARYLAND

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SECTION 1

EXECUTIVE SUMMARY

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1.0 EXECUTIVE SUMMARY

National Waste Managers, Inc. (NWM) proposes to reclaim approximately 114.4 acres (measured at inside top edge of perimeter berm), formerly used for sand and gravel mining, with an engineered state-of-the-art, rubble landfill that will provide disposal airspace for Anne Arundel County rubble waste disposal for 12 years. The site consists of a 480-acre parcel located near Odenton, Maryland, as shown on Figure 1-1. The total area of disturbance is approximately 193.2 acres, as shown on Figure 1-1.

The landfill is proposed to have 21 cells, to allow sequential development. The landfill cells will be lined with a state-of-the-art, low-permeability liner system to block leachate (water which contacts the waste) from contacting groundwater. Each cell will be equipped with a leachate collection and removal system, which will convey the leachate through a force main to the on-site leachate storage tanks. The leachate will be transported to a local treatment plant for treatment and disposal. Depending on actual leachate characteristics and treatment cost, NWM may eventually propose for regulatory approval an on-site treatment plant with discharge to surface water in accordance with appropriate National Pollution Discharge Elimination System (NPDES) permit.

As the landfill achieves final grades, the closure cap will be constructed. By constructing the closure cap in a phased approach, as top of waste grades are achieved, ongoing leachate generation is reduced, and stormwater can be managed through the series of terraces, downchutes, perimeter channels; culverts, and stormwater retention basins.

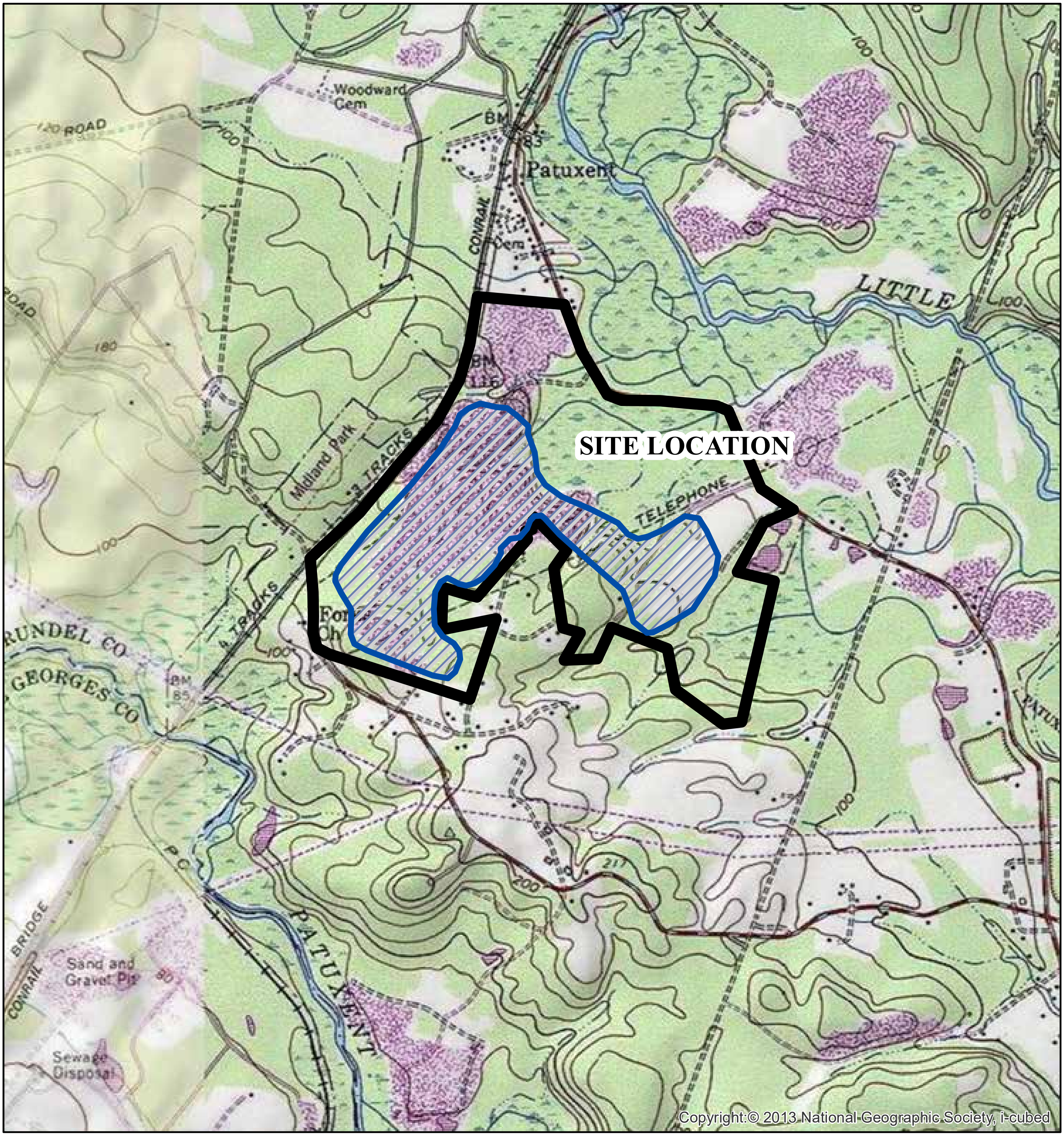
While there is a general movement in stormwater management to promote infiltration, in the case of landfills, infiltration of stormwater through the waste is undesirable. However, the on-site stormwater controls will attenuate peak runoff rates, so as not to increase the runoff rate discharge leaving the site.

The Phase II Permit Application, prepared by Advanced GeoServices Corp. (AGC Montrose) and dated June 2020, was approved by Maryland Department of the Environment (MDE) on June 17, 2020. This Phase III Permit Application was prepared in accordance with Code of Maryland (COMAR) Regulations, as required for issuance of a Refuse Disposal Permit from MDE. Landfill construction and operation will comply with Federal, State, and County Regulations pertinent to waste acceptance, sediment control, stormwater management, flood plains, wetlands, environmental protection, public health, and safety.

National Waste Managers, Inc., at the following address, will be responsible for operation and maintenance of the proposed rubble landfill.

National Waste Managers, Inc.
2900 Linden Lane, Suite 300
Silver Spring, MD 20910
Telephone: 301-495-1520

FIGURES



Copyright:© 2013 National Geographic Society, i-cubed

Legend

▨ FILL BOUNDARY

□ PROPERTY BOUNDARY

0 0.1 0.2 0.4 0.6 0.8 Miles

REFERENCE

1. MAP FROM U.S.G.S. 7.5 MINUTE QUADRANGLES

CHESAPEAKE TERRACE RUBBLE LANDFILL
4TH ASSESSMENT DISTRICT
ANNE ARUNDEL COUNTY, MARYLAND

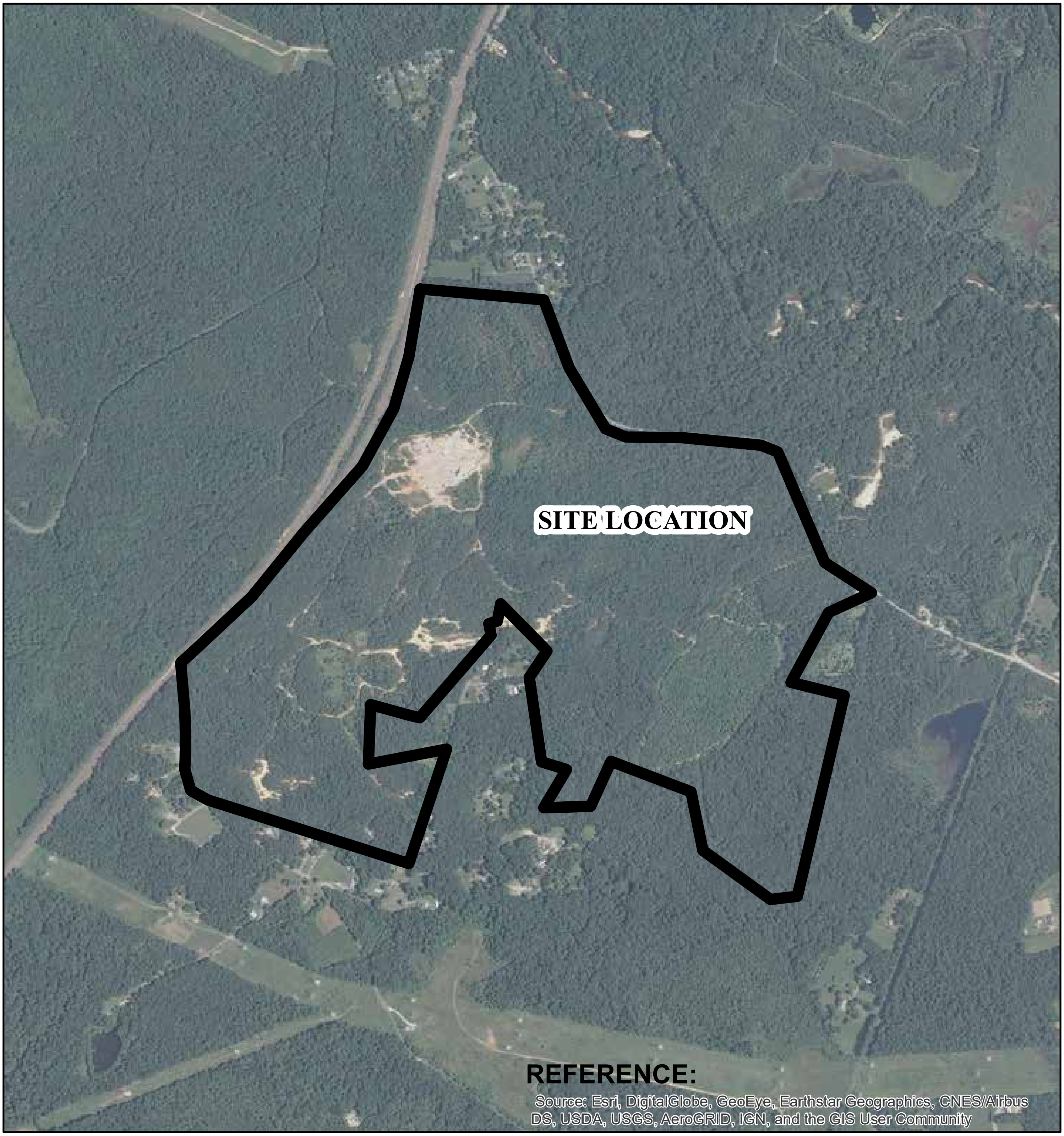
SITE LOCATION MAP

N
W E
S

ADVANCED GeoServices™
Engineering for the Environment. Planning for People.
1055 ANDREW DRIVE, SUITE A
WEST CHESTER, PENNSYLVANIA 19380
Tel: 610.840.9100 Fax: 610.840.9199 Web: www.advancedgeoservices.com

Scale:	
Drawn By:	GCR
Checked By:	VEF
Project Mgr.:	VEF
Originated By:	GCR
Project No.:	2018-3854
Drawing Date:	4/29/2019
Sheet No.:	1 of 2
Revision Number:	0

FIGURE 1-1



REFERENCE:

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

▭ Property Boundary

Miles
0 0.075 0.15 0.3 0.45 0.6

N
W E
S

CHESAPEAKE TERRACE RUBBLE LANDFILL
4TH ASSESSMENT DISTRICT
ANNE ARUNDEL COUNTY, MARYLAND

ORTHO LOCATION MAP

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FIGURE 1-2

SECTION 2

WASTE ACCEPTANCE AND AREA TO BE SERVED

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2.0 WASTE ACCEPTANCE AND AREA TO BE SERVED

The Code of Maryland (COMAR) Regulations Title 26 Subtitle 4 Chapter 7 (herein after referenced as 26.04.07), identifies four categories of solid waste landfills in Maryland:

- Municipal Solid Waste (MSW) – defined as waste generated by a community, excluding wastes defined otherwise (COMAR 26.04.07.02). Traditionally MSW is residential and office and retail business wastes.
- Land Clearing– limited to soils, trees stumps, root mats, brush and limbs, logs, vegetation, and rock (COMAR 26.04.07.11)
- Industrial Waste – nonhazardous industrial solid wastes (COMAR 26.04.07.19)
- Rubble Waste – typically debris associated with construction demolition (see Section 2.1)

The Chesapeake Terrace Rubble Landfill will only accept wastes COMAR-approved “rubble waste.”

2.1 Acceptable and Unacceptable Waste

The Chesapeake Terrace Rubble Landfill is located in Odenton, Anne Arundel County, Maryland. The rubble landfill will accept the types of rubble waste listed in the COMAR 26.04.07.13 summarized, as follows:

- Land Clearing Debris, includes the following:
    - Earth material such as clays, sands, gravels, and silts;
    - Topsoil;
    - Tree Stumps;
    - Root Mats;
    - Brush and Limbs;
    - Logs;
    - Vegetation; and,
    - Rock.

- Demolition Debris, includes the following:
    - Acceptable demolition debris associated with the razing of buildings, roads, bridges, and other structures includes structural steel, concrete, bricks (excluding refractory type), lumber, plaster and plasterboard, insulation material, cement, shingles and roofing material, floor and wall tile, asphalt, pipes and wires, and other items physically attached to the structure, including appliances if they have been or will be compacted to their smallest practical volume.
    - Unacceptable demolition debris includes industrial waste or byproducts, any waste materials contained within a structure or on the grounds of the structure being demolished that are not physically part of the structure, or which are comprised of or contain materials that pose an undue risk to public health or the environment.

- Construction Debris, includes the following:
    - Acceptable construction debris is structural building materials including cement, concrete, bricks (excluding refractory type), lumber, plaster and plasterboard, insulation, shingles, floor, wall and ceiling tile, pipes, glass, wires, carpet, wallpaper, roofing, felt, or other structural fabrics. Paper or cardboard packaging, spacing, or building materials, provided that they do not exceed 10% by volume of the waste, may be accepted at the rubble landfill. Paint containers, caulk containers, or glaze containers are acceptable, provided that they are empty and any residual material that is dried before acceptance at the rubble fill, and further provided that this waste category does not exceed 1% by volume of the waste accepted at the rubble landfill.
    - Unacceptable construction debris includes commercial, domestic, or industrial wastes or byproducts, paint, tar or tar containers, caulking compounds, glazing compounds, paint thinner or other solvents or their containers, creosote or other preservatives or their containers, tile, paneling, or carpet cement or other adhesives, and other solid waste which may contain an unacceptable waste or substance as may be determined by the approving authority to be unacceptable.

- Tires. Scrap tires may be accepted at the facility and managed in accordance with the requirements of a scrap tire collection facility license issued under COMAR 26.04.08. Disposal of tires in a landfill is prohibited.

- Asbestos Waste. Asbestos waste is acceptable provided that the material that is received is packaged and labeled as specified in COMAR 26.11.15.04, and is managed in the following manner:
    - Prior notification to the landfill supervisor is required;
    - The waste asbestos is unloaded carefully to prevent emission of fibers into the air;
    - The area used for burial of asbestos shall be restricted to the working face of the landfill, or a separate cell dedicated solely to asbestos disposal;
    - The waste shall be completely covered with earth or other rubble and may not be compacted or driven over until sufficient cover has been applied to prevent the release of asbestos fibers to the atmosphere during compaction or application of other cover material; and,
    - Operators at the landfill shall wear respiratory protection approved by the National Institute for Occupational Safety and Health for protection against asbestos fibers, and protective clothing when considered necessary.
    - Household Appliances and White Goods. Household appliances and white goods are acceptable provided that any refrigerant is removed from the appliances before burial in the landfill and is managed in accordance with §608 of the Federal Clean Air Act (42 U.S.C. §7671g).
    - Processed Debris. Processed debris is acceptable only at a rubble landfill having a liner and leachate collection system constructed to the standards as specified in Maryland Department of the Environment (MDE) COMAR Regulations 26.04.07.16.

- Other Waste Materials. Waste materials not specifically listed in this section may not be disposed of in a rubble landfill before receiving written approval of the Approving Authority.

The Chesapeake Terrace Rubble Landfill has a total gross design capacity of approximately 9.3 million cubic yards (MCY). Assuming three percent (10%) of the volume is reserved for daily/weekly cover, the net disposal capacity is 8.4 MCY..

The average daily rubble intake used for calculating the life of the Landfill is 1,602 tons per day, and an average unit weight of 0.59 tons/cubic yard. At the average daily rubble intake rate (5-day per week operation), the life of the Chesapeake Terrace Rubble Landfill facility is 12 years. The average daily rubble intake is used for estimating purposes and the actual rubble intake rate may lead to a different facility life span. Often, waste intake varies by season and day of the week. As such, some days may have higher intakes, while others may be lower. At the end of life, the landfill will be closed, maintained and monitored according to the COMAR regulations and the facility's Closure and Post-Closure Plan, included in Section 15 of the Phase III Permit Application.

2.2 Signage

To be clear on the types of wastes accepted at the site, there will be two large signs posted near the scalehouse at the main entrance listing wastes that are and wastes that are <u>not</u> acceptable. The details for these signs are provided on Drawing 9.

Due to the number of vehicles and the traffic expected within the property, there will also be a series of other signs controlling traffic throughout the site, including but not limited to, the list of signs below:

- Stop
- Yield
- Do Not Enter
- Speed Limit (various)
- No Shoulder
- Wrong Way
- Steep Grade
- Authorized Vehicles Only
- Back-in Parking Only

A variety of other signs will be used as needed.

2.3 Area and Population Served

The Chesapeake Terrace Rubble Landfill is located in Anne Arundel County, Maryland. Due to the cost of transporting rubble, it is a reasonable assumption that most of the rubble waste will originate within a 75-mile radius of the landfill. This area includes the following Maryland counties and their corresponding populations:

County	2020 (projected) Population
Anne Arundel	556,100
Baltimore	842,600
Calvert	100,450
Caroline	40,300
Carroll	197,400
Charles	177,200
Dorchetser	36,300
Frederick	287,900
Harford	276,500
Kent	22,200
Montgomery	1,075,000
Prince George’s	921,900
Queen Anne’s	55,650
Saint Mary’s	130,100
Somerset	28,300
Talbot	40,050
Wicomeco	107,450

Population taken from web page https://msa.maryland.gov/msa/mdmanual/01glance/html/pop.html#county

The total population of these counties is nearly 5 million people.

SECTION 3

PROJECT DESCRIPTION

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3.0 PROJECT DESCRIPTION

3.1 Regulatory Compliance

Table 3.1 - Phase III Application Compliance with COMAR Regulations

COMAR Regulation 26.04.07.16 Phase III	Description	Where addressed
1.	A map which designates the property boundaries, the actual area to be used for filling, and existing and proposed structures and on-site roads	Drawings
2.	A description of any vehicle weighing facilities, communications (telephone, radios), maintenance and equipment storage facilities, and water supply and sewage systems.	Section 12.0
3.	a. A description of the types of solid waste: (i) to be accepted. (ii) NOT to be accepted. b. Area and population to be served by the facility.	Section 2.0
4.	The anticipated quantities of solid waste to be accepted and the calculations used to determine the useful life of the facility	Section 5.0
5.	Proposed methods of collecting and reporting data on the quantities and types of solid waste received and for revising facility life expectancy projections.	Section 12.0
6.	The volume and type of available cover material, the calculated volume of earth needed for periodic, intermediate, and final cover, the location of earth stockpiles, and provisions for saving topsoil for use as final cover.	Section 8.4
7.	Proposed means of controlling unauthorized access to the site.	Section 12.0
8.	Proposed operating procedures including: a. Hours and days of operation b. Number and types of equipment to be used c. Number of employees and their duties d. Provisions for fire prevention and control e. Means of preventing public health hazards and nuisances from blowing paper, odors, rodents, vermin, noise, and dust f. Proposed method of daily operation including wet weather operation	Section 12.0
9.	The location and depth of solid waste cells and the sequence of filling.	Drawings
10.	Natural or artificial screening to be used.	Section 6.3
11.	Methods of controlling on-site drainage, drainage leaving the site, and drainage onto the site from adjoining areas.	Section 17.0 & Drawings

COMAR Regulation 26.04.07.16 Phase III	Description	Where addressed
12.	A contingency plan for preventing or mitigating the pollution of the waters of the State of Maryland.	Section 16.0
13.	Proposed methods for covering and stabilizing completed areas.	Section 18.0
14. & 15.	A system for monitoring the quality of the waters of the Sate around and beneath the site, including the location and types of monitoring stations, and the methods of construction of monitoring wells.	Section 16.0
16.	A schedule for implementing construction and implementation of the operation plans and engineering specifications once the refuse disposal permit has been issued.	Section 7.2
17.	A landfill closure and post-closure plan to be followed cover a period of not less than 5 years after application of final cover.	Section 15.0
18.	The name, address, and telephone number of the person or agency responsible for the maintenance and operation of the site.	Section 1.0
19.	An engineered design for a liner system and leachate collection system for the proposed rubble landfill based upon geotechnical information developed in Phase I and Phase II.	Sections 9.0 & 10.0 and Drawings
20.	A proposed method, engineering specifications, and plans for the collection, management, treatment and disposal of leachate generated at the facility, including the calculations used to determine the estimated quantities of leachate to be generated, managed, stored, treated, and disposed.	Section 10.0

3.2 Existing Site

The site of the proposed rubble landfill is located southeast of Fort Meade in Odenton, Maryland. The property is bounded by Patuxent Road to the north, CSX/Amtrak rail lines to the west, Conway Road to the south, and Patuxent River Park to the northeast. See Location Map on Drawing 2. The property, consisting of approximately 480 acres, was previously used to mine sand and gravel. Surface runoff drains across the site in a northerly direction toward a 100-year flood plain, between the proposed rubble landfill and Patuxent Road. See Site Plan on Drawing 2.

National Waste Managers, Inc. proposes to reclaim approximately 114.4 acres, formerly used for sand and gravel mining, with an engineered state-of-the-art rubble landfill that will provide air space for rubble waste disposal for 12 years. The site consists of a 480-acre parcel located near Odenton, Maryland, as shown on Drawing 2. Existing topography and mapped wetland boundaries are presented on Drawing 2. The proposed landfill limit of waste is approximately 114.4 acres, as shown on Figure 3.

The landfill is proposed to have 21 cells, to allow sequential development. The landfill cells will be lined with a state-of-the-art, low-permeability liner system to block leachate (water which contacted the waste) from contacting groundwater. Each cell will be equipped with a leachate collection and removal system, which will convey the leachate through a force main to one of the on-site leachate storage tank. Final disposition of the leachate from the storage tank is addressed under Section 10.11 Leachate Disposal, of this Phase III Report.

As the landfill achieves final grades, the closure cap will be constructed. The closure cap will also include a low-permeability barrier layer designed and constructed to prevent precipitation from infiltrating into the filled waste material. By constructing the closure cap as grades within cells or portion of cells are achieved the volume of leachate requiring management is reduced. Precipitation falling on the completed cap (i.e., stormwater runoff) is managed through the series of controls and diversion (such as terraces, down-chutes, perimeter channels and culverts) that direct the water to stormwater retention basins situated around the landfill. The stormwater retention basins provide storage and allow the water to be discharged in a limited/controlled fashion. Drawing 3 presents the conceptual layout and configuration for the proposed landfill cells and stormwater retention basins. Additional details regarding landfill layout, configuration, closure cap construction and stormwater management are presented throughout this Phase III Permit Application.

3.3 Topography, Drainage and Features

3.3.1 On-Site

A topographic base map of the site is shown on Drawing 2. This map shows natural drainage features, wetlands, the 100-year flood plain, property lines, and forested areas. Extensive surface mining for sand and gravel has taken place in the northwestern portion of the proposed landfill area. The results of this past mining activity is the surface is uneven and barren in some areas. There are no on-site structures, utility pipelines, storage tanks, or water supply wells.

A ridge with elevations up to 196 feet (ft) above mean sea level (amsl) is located on and adjacent to the southern property line. The land surface across the site slopes north from this ridge toward the Little Patuxent River which is at an elevation of approximately 60 ft amsl. The vast majority of surface water from the site drains to the northeast toward the Little Patuxent River. The extreme western corner of the property drains to the west toward the Patuxent River.

3.3.2 Localized

The topography beyond the property can be viewed on Figure 2 from the Phase II Permit Application (included here as Attachment 3A), which shows profiles in four directions through the site. These profiles are taken from GoogleEarth® so the elevations are +/-5-ft amsl. The value of these profiles is that they show the relative elevations of the site compared to the surrounding communities, from 3 to 5 miles from the site. The data shows that the site is located along a localized high-point created by the Little Patuxent and Patuxent River valleys. The areas north, west and east are at lower elevations than the southern portions of the site. The elevations beyond the southern limits of the site generally slope downward to the Patuxent River. This means that surface water is generally not running onto the site from off-site sources.

3.4 Access/Site Entrances

Three entrances are shown for the site, as depicted on the Design Drawings. Construction of only one site entrance is required by COMAR regulations and Maryland Department of the Environment (MDE). The main entrance is intended to be the East Entrance (Drawings 4 and 5) from Conway Road, as stipulated in the special exception issued by the County, with access for emergency vehicles provided via a 12 feet wide lane from Patuxent Road (see Drawing 64). The Optional North and South Entrances, Drawings 89 and 90,respectively, are presented for approval in the permit but will only be constructed in theevent that acquisition of the property, right-of-ways or easements required for the EastEntrance is unsuccessful. NWM recognizes that the stipulation in the special exceptionmust be changed or nullified before the optional entrances may be utilized.

If the Optional North Entrance is constructed in lieu of the East Entrance, stipulations under construction sequencing drawings for the Optional North Entrance are maintained. If the Optional South Entrance is designated by the Owner to be constructed in lieu of both the East and North Entrances, then a variance from MDE (as specified under Section 7.3, "Variance from Sequence of Construction for Landfill Cells") must be obtained, prior to beginning construction.

Information on Drawing 63 "Sequence and General Notes for Construction" describes criteria for landfill construction.

Primary methodology associated with landfill construction over the life of cell construction and waste placement operation is depicted on Intermediate Construction Stage Plans (see Drawings 64 through 81), which depict construction of landfill cells and appurtenances from beginning to end of landfill construction.

Contract Documents for landfill construction, per Specifications under Section 7.6, "Preparation of Contract Documents for Intermediate Stage Construction", will be prepared per Intermediate Construction Stage Plans shown on Drawings hereunder.

3.4.1 Site Entrance Infrastructure and Queue Lanes

As shown on Drawings 4and 5 for the East Entrance, and on Drawings 89 and 90 for the optional entrances, scale house and truck scales, maintenance building, and wheel wash with adjacent concrete clean-out are provided for each of the three site entrances. See "Operations Plan" in Section 12.0.

It is anticipated that the facility will accept rubble waste at the rate of approximately 1,602 tons per day. Per "Operations Plan" in Section 12.0, at this waste acceptance rate, it is expected that almost all waste will be delivered to the site by semi-trailers. Under the assumption that each semi-trailer delivers 20 tons waste to the site, 80 semi-trailers per day would be required to meet 1,602 tons per day throughput.

Per "Operations Plan" Section 12.6.2.3, approximately two minutes processing per vehicle would be required to move a vehicle from the truck scale onto the landfill perimeter access road. During an 8-hour day, average arrival rate of semi-trailers at the site would be approximately 6 minutes. In consideration of the eventuality that peak traffic consisting of simultaneous arrival of semi-trailers at the scale house, queue lanes for each of the three site entrances are provided (per description under Sections 3.4.2 through 3.4.5). Regardless of which entrance is eventually constructed, trucks will not be permitted to queue onto public roads.

3.4.2 Assumed East Entrance

The assumed East Entrance would be constructed as shown on Drawings 4, 5, 55, and 56. The East Entrance access road from Conway Road to the scale house is approximately 5,000 feet long. Assuming the length required to queue a single tractor trailer is 60 feet, and no movement past the scale house, all of the landfill's estimated daily 80 waste trucks could be queued on the East Entrance access road. Access for emergency vehicles will be provided via a 12 feet wide lane from Patuxent Road (see Drawing 89).

The portion of the East entrance access road from Conway to the property line is a gravel-surfaced road. From the property line to the scales through the turn onto the landfill perimeter road, the road surface is paved.

3.4.3 Optional North Entrance

Optional North Entrance would be constructed as shown on Drawings 89 and 57.

Three lanes, approximately 600 feet long each, are provided. Assuming single vehicle queue length of 60 feet and no movement past the scale house, 20 of the landfill's estimated daily 80 waste trucks could be queued on two North Entrance lanes. The remaining lane would be reserved for outbound traffic. As warranted, outbound traffic would be queued on-site and the outbound lane would be used by emergency vehicles entering the site, if the main path is blocked with waste trucks.

3.4.4 Optional South Entrance

Optional South Entrance would be constructed as shown on Drawings 90 and 54. Four approximately 450 feet long lanes are provided. Assuming single vehicle queue length of 60 feet and no movement past the scale house, 22 of the landfill's estimated daily 80 waste haulers could be queued on three South Entrance lanes. The remaining lane would be reserved for outbound traffic. As warranted, outbound traffic would be queued onsite and-the outbound lane would be used by emergency vehicles.

3.4.5 Emergency Exit

Regardless of which entrance is constructed, consistent with the redundant design approach associated with landfills, so that each system has a primary and a “backup”, there will be a road for use as an “emergency exit”, in the event the Entrance is blocked (e.g., downed power lines, broken-down truck, loss of power at the automatic gates, etc.). This emergency exits will be one 12-foot wide, paved lane, as shown on Drawing 64, at the location of the Optional North Entrance.

3.5 Proposed Rubble Landfill Description

The proposed rubble landfill will consist of approximately 114.4 acres dedicated for landfill waste disposal, or airspace. Total site disturbance to construct the facility (including the access road, leachate collection and storage area, stormwater management facilities, etc.) is approximately 193.2 acres. The rubble landfill will consist of a series of excavated cells, contained within a perimeter berm (Cells 1 through 10 in the West Section and Cells 11 through 16 in the East Section, as shown on Drawings 10 and 11). A summary of cell areas is provided in the following table.

Summary of Cell Areas	
Cell	**Area (acre)**
1	13.2
2	7.5
3	4.9
4	5.5
5A	5.6
5B	3.4
5C	4.4
5D	2.9
5E	3.2
5F	1.7
6	5.2
7	6.7
8	6.0
9	4.0
10	9.6
11	7.0
12	6.7
13	3.4
14	4.3
15	4.7
16	4.5

The landfill will have a series of containment systems to protect human health and the environment from potential releases form the landfill. These containment systems include the following:

- Liner System
- Leachate Collection and Management
- Cap/Closure System
- Landfill Gas Collection and Control
- Stormwater Management

These systems are described briefly below and in greater detail throughout the Phase III Permit Application.

Site entrances are described under Section 3.4.

3.5.1 Liner System

Each landfill cell will contain a liner system. The proposed design includes a liner system configuration specifically meeting the COMAR requirements listed in 26.04.07.16C. The proposed liner system components include the following basic components, from top to bottom:

- Select Waste: A 48-inch protective layer to protect the integrity of the underlying layers;
- Leachate Collection Layer: A 24-inch leachate collection and removal system to remove leachate, precipitation that comes into contact with the waste, from the landfill;
- Barrier Layer: Layer to prevent leachate from percolating beyond the landfill liner system and into the underlying soils and groundwater; and
- Prepared Subbase: A 24-inch layer with reduced hydraulic conductivity in intimate contact with the barrier layer intended to minimize the leakage from the barrier layer, in the event the barrier layer is compromised.

As indicated by the description of the liner system, most items at a landfill have a primary system and then a backup for contingency – in the event the primary system fails. This redundancy is reflected in the liner system with the primary barrier layer and the prepared subbase backup barrier layer.

The COMAR-required liner system identifies the use of natural soil materials or synthetic materials for certain liner system components. The liner system proposed by NWM utilizes the synthetic alternatives provided for in the COMAR regulations for the barrier layer (60 mil HDPE geomembrane) and a portion of the leachate collection layer (geocomposite drainage layer (GDL) located on top of the geomembrane and at the bottom of the 24-inch thick leachate collection layer).

Geosynthetics are widely preferred and used over natural soil materials for many of the liner system components due to consistency of product, ease of installation, improved performance over natural materials relative to protection of groundwater, and their use for this purpose for more than thirty (30) years in hazardous waste, municipal solid waste, and industrial waste applications.

Landfill liner systems with properly installed geosynthetic components are viewed as superior to systems with natural soils, for a number of reasons, including but not limited to:

- Consistency of the geosynthetic products over multiple years of construction;
- Permeability being several orders of magnitude lower than the permeability of natural soils, providing more protection against leakage;
- Inert nature of the geosynthetics, averting possible chemical reactions with the leachate or waste disposed at this site;

- Proven-track record of using geosynthetics as barrier components of liner systems for more than 30 years in municipal waste landfills, hazardous waste landfills, and industrial waste landfill;
- Reduced traffic from hauling natural materials to site for construction;
- Reduced timeline for each phased construction effort; and,
- Preservation of natural soils to reducing the needing for soils mining.

More detailed discussions of materials and their selection is provided in Section 9 of this Phase III Permit Application. Liner system details are provided on Drawings 14 through 16.

The landfill cell floor grades have been designed to maintain 3 feet minimum distance (after landfill settlement) from the bottom of the prepared subbase to the Highest Predicted Groundwater Contours indicated on Phase II Permit Application, as discussed further in Section 4.0.

3.5.2 Leachate Management System

The leachate collection system has been designed in accordance with COMAR 26.04.07.16.C. The bottom limit of the leachate collection system is defined by the GDL, which will be installed directly on the geomembane liner component. The geomembrane layer will be in intimate contact with the top of the prepared subbase. Elevation control for the top of subbase grading presented on Drawings 10 and 11, is critical to ensure that 2% minimum required bottom slopes remain following any predicted long term settlement. During construction, bottom elevations shall be laid out utilizing the sump invert elevations and minimum slopes presented on Drawings 6 and 7, and 10 and 11.

Leachate collection system details are shown on Drawings 19 through 21. Leachate will be intercepted by the leachate collection layer contained within the liner system, immediately above the barrier layer. Leachate will flow within the leachate collection layer to the leachate collection sump. Within the cell sump (i.e., low spot), submersible pumps compatible with the leachate will transfer the leachate out of the cell into the leachate force mains and then to one of two Leachate Storage Facilities.

From the leachate storage tanks, the leachate will be hauled off-site for disposal.

Environmental Recovery Corporation (ERC) of Maryland, located in Baltimore, has provided written confirmation that they can process and treat the estimated leachate volume of 75,000 gallons per day. A copy of that confirmation is attached to this response to comments letter. No pre-treatment is anticipated prior to shipment.

Details and layout of the leachate management system are provided on Drawings 17 through 29. Detailed description pertinent to leachate collection system design and installation is presented in Section 10.0 "Leachate Management System" and in Section 14.0, "Construction Specifications", respectively.

Depending on the nature of the waste disposed, the levels of contaminants in the leachate, and the volume of leachate produced (which is directly linked to the amount of rainfall), the owner may choose, in the future to develop an on-site wastewater treatment plant to treat leachate and obtain a NPDES discharge permit.

3.5.3 Cap/Closure System

3.5.3.1 Final Cover Layer

As waste grades attain the maximum permitted filling elevations presented on Drawings 30 and 31, a minimum24-inch thick Final Cover will be placed. The Final Cover Surface shall be graded to promote runoff and minimize erosion. Minimum and maximum Closure Cap slopes are four percent (4%) and twenty-five (25%), respectively. In addition, to ensure adequate flow capacity for the proposed cap drainage layer, the minimum cross-slope for the Final Cover surface across proposed terraces and haul road benches shall be 7-percent.

.

3.5.3.2 Closure Cap

The Final Cover Layer will be the supporting layer for the Closure Cap. Pursuant to COMAR 26.04.07.21G, the Closure Cap will consist of the following components, from top to bottom:

- Vegetative Stabilization – Perennial cover as recommended by the Anne Arundel County Soil Conservation District, with sufficient lime and commercial fertilizer applied to sustain vegetative growth.
- Final Earthen Cover – 24-inch thick (minimum) soil layer, including a upper 6-inch thick vegetative support layer.
- Drainage Layer - Geocomposite Drainage Layer (GDL) or 6-inch thick drainage layer with a permeability equal to or greater than 1×10^{-3} cm/sec. We are requesting MDE approve of the GDL in-lieu of the 6-inch thick drainage layer.
- Low Permeability Cap - 40 mil (minimum) synthetic (textured LLDPE) material with a maximum permeability of 1×10^{-10} cm/sec.

The purpose of the closure cap is several-fold, including to:

- Prevent infiltration of precipitation into the waste,
- Prevent contact with the waste, by people or animals, and
- Prevent burrowing animals from disturbing the waste.

More detailed discussion of the Closure Cap system and selection of materials is provided in Section 9.0. Grading plans and details associated with the final cover layer and the closure cap system are provided on Drawings 30 through 35. Materials specifications are provided in Section 14.

3.5.4 Landfill Gas Collection and Control

A byproduct of landfill disposal of waste is often gaseous emissions, as the waste decomposes, when exposed to infiltrating rainwater or the mixture of the wastes disposed. The exact character and nature of these emission, dubbed “landfill gas”, varies based on the composition of the wastes disposed, but the primary component is usually methane. Depending upon the concentration of methane in the landfill gas, a passive landfill gas management system may be used. However, if concentrations are higher, so that they can sustain a landfill gas flare or even be used to produce power for on-site use, an active landfill gas collection and control system should be installed.

For municipal waste landfills, an active landfill gas (LFG) collection and control system is required. For rubble waste, the need for an active system varies with the type and volume of waste deposited. For this application NWM has included information and details for an active LFG collection and control system will be needed. This LFG system will include the following components:

- LFG monitoring probes at the property line to verify LFG is not in the soils or groundwater at the property limits.
- LFG extraction wells installed in the waste (the extraction wells will be capable of functioning in passive mode if gas generation rates cannot support an active gas system and use of a passive system is approved by MDE).
- LFG laterals and headers to convey LFG from the wells to a LFG Flare to burn the LFG.
- A blower which will impose a negative pressure on the system to “suck” the LFG out of the landfill. The blower is typically included with the flare and recommended by the flare manufacturer. (The size and configuration of the blower and flare will be a function of the volume of gas being generated/required extraction rates, methane concentrations and size and layout of the area of extraction.)

Further discussion of the LFG Collection and Control System is provided in Section 11.

3.5.5 Stormwater Management

One of the requirements of COMAR 26.04.07 and 40 CFR 257 is the management of surface water run-on from upgradient sources and the management of stormwater runoff from landfills. 40 CFR 257 and 258 list requirements for coal-combustion residual and municipal solid waste facilities. 40 CFR 258.26 (a) specifically requires

> “(1) A run-on control system to prevent flow onto the active portion of the landfill during the peak discharge from a 25-year storm;
> (2) A run-off control system from the active portion of the landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm.”

While this is a Rubble Waste facility so these federal requirements are not applicable, they are relevant and appropriate. Thus, surface water/stormwater runoff controls at the Chesapeake Terrace Rubble Landfill were designed for the 25-year, 24 hour storm event.

The stormwater management systems consists of a number of components, including the following:

- Terraces on the closure cap
- Downchutes to convey flow from the terraces, off the landfill
- Perimeter channels and swales to convey flow from the downchutes and other operational areas to the stormwater management basins
- Culverts convey flow at road or driveway crossings

Detailed design information about the stormwater management system is provided on Drawings 38 through 53 and described in Section 17.

3.6 Solid Waste Management Plan

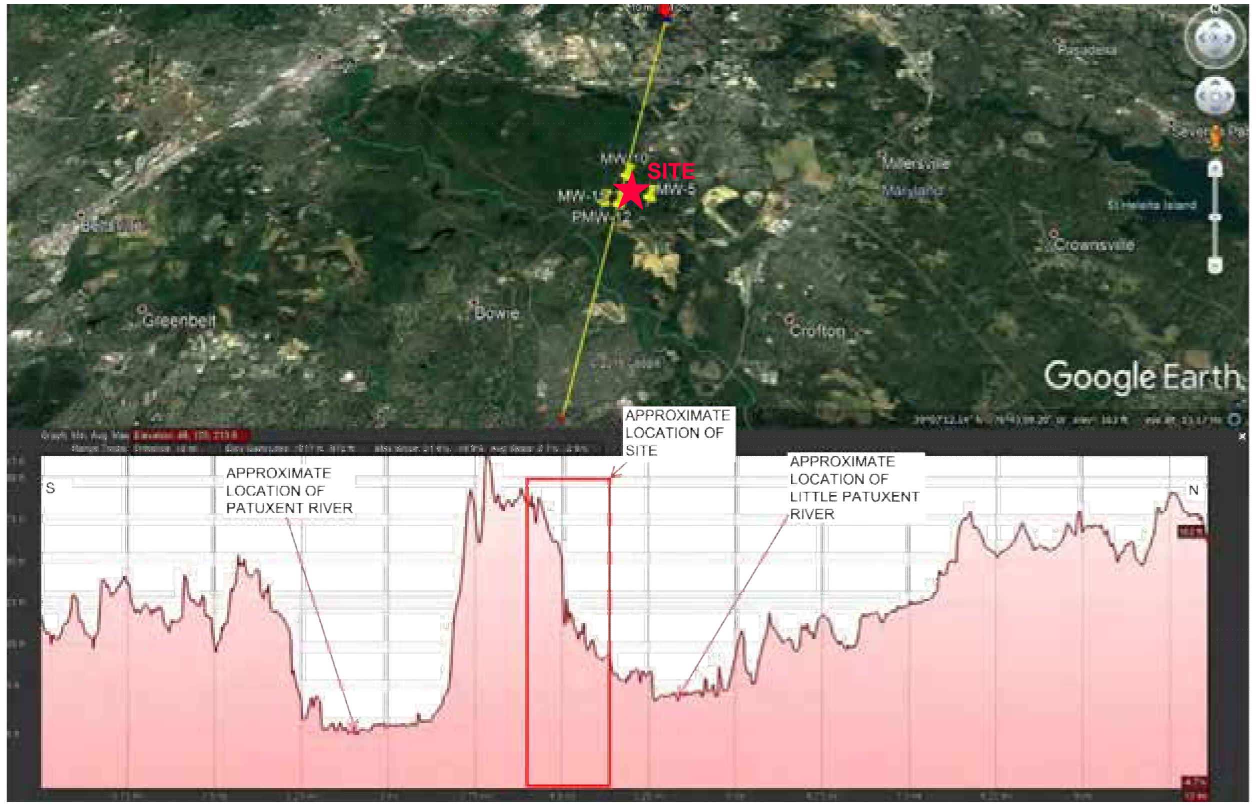
The Chesapeake Terrace Site was included in the Anne Arundel County 10-Yr Solid Waste Management Plan 2013-2023 as a proposed facility.

ATTACHMENT 3A

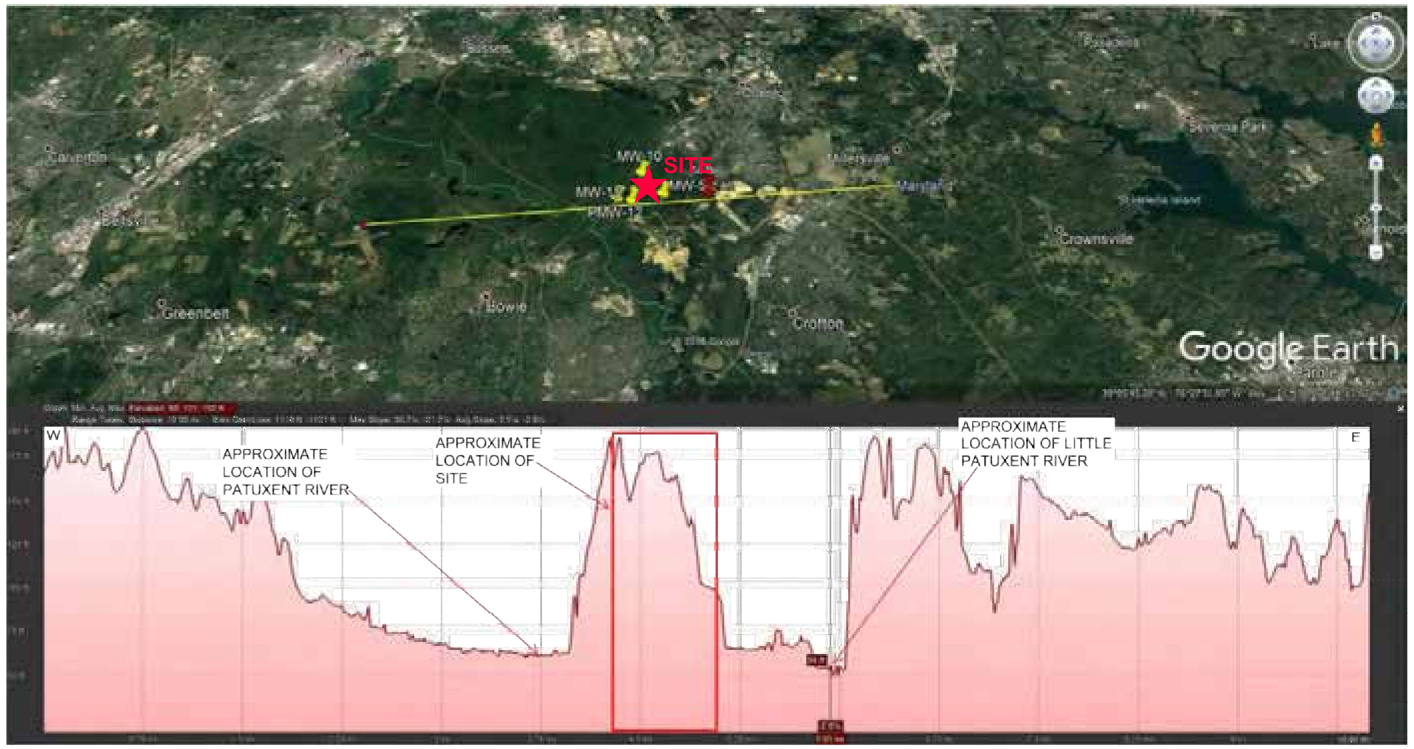
Regional Topographic Information

NOTES

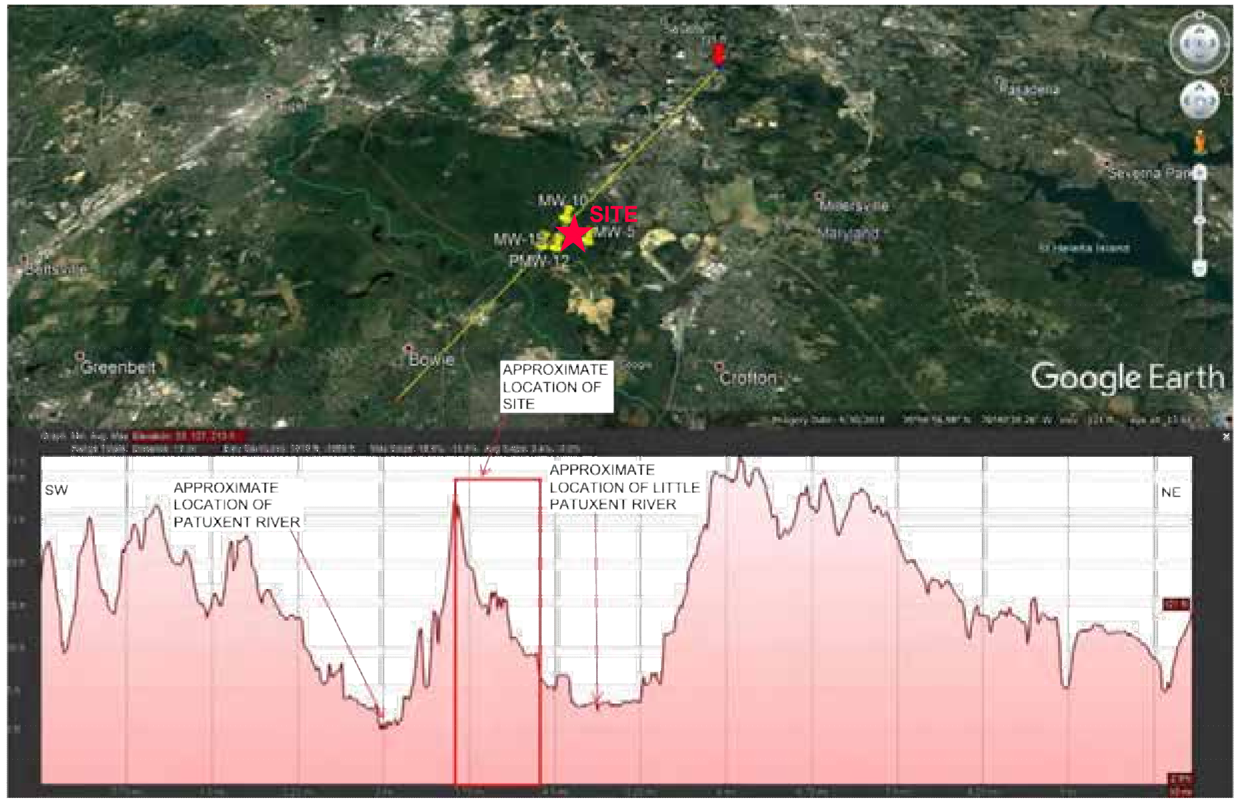
1. TOPOGRAPHIC AND MAP DATA SHOWN IS FROM GOOGLE EARTH UPDATED 4/30/2018.
2. THE PROFILES SHOWN REPRESENT THE GROUND SURFACE ELEVATIONS OF 10–MILE SECTIONS THAT ARE ROUGHLY CENTERED UPON THE PROPOSED LOCATION OF THE CHESAPEAKE TERRACE RUBBLE LANDFILL.
3. THE GROUND SURFACE ELEVATIONS SHOWN ARE NOT EXACT. ELEVATIONS SHOWN ARE INTENDED TO DEMONSTRATE THAT THE LOCATION OF THE PROPOSED CHESAPEAKE TERRACE RUBBLE LANDFILL IS ON A LOCALIZED HILL WHICH IS SEPARATED TOPOGRAPHICALLY FROM THE SURROUNDING AREAS BY THE PATUXENT AND LITTLE PATUXENT RIVERS.



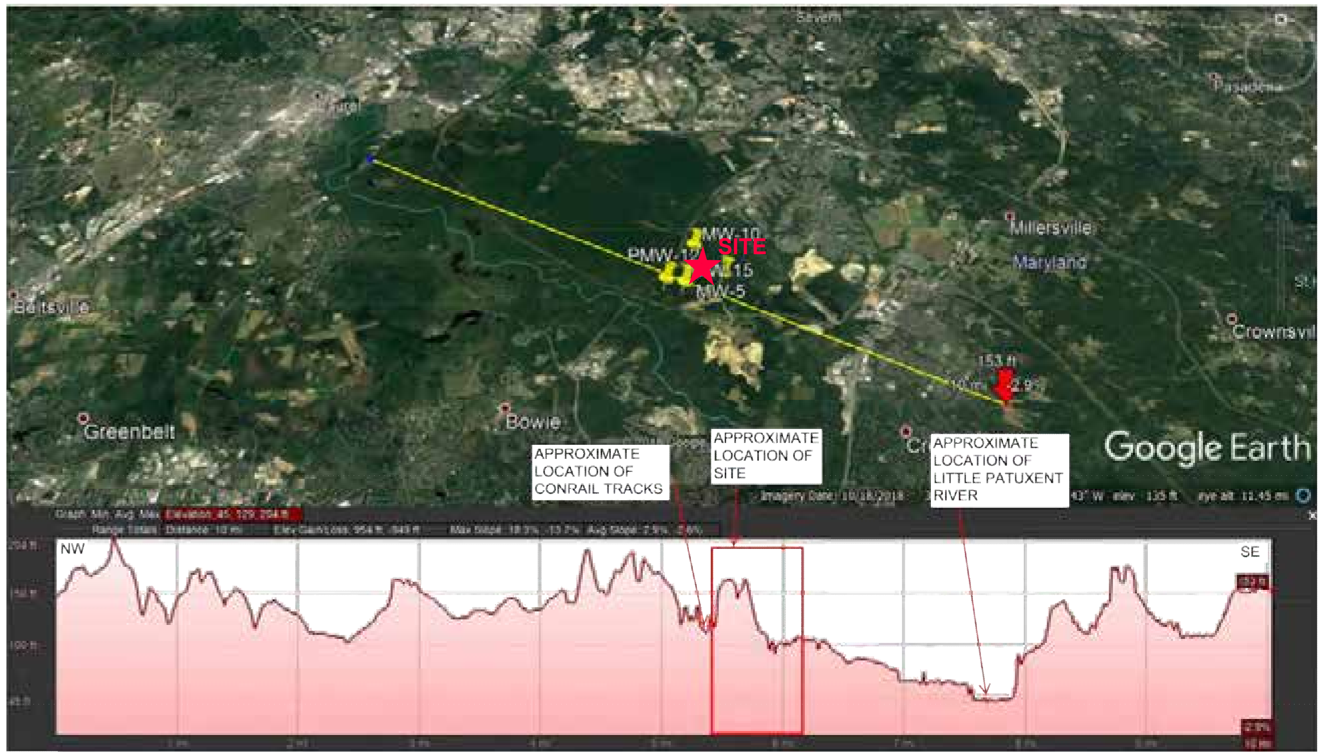
PROFILE A



PROFILE C



PROFILE B



PROFILE D

VERONICA FOSTER
LICENSED PROFESSIONAL ENGINEER
MD # 35645

No. 35645

DATE:	REVISION:
4/30/2020	REVISED TO ADDRESS MDE COMMENTS (PGS/VEF)

NATIONAL WASTE MANAGERS
PHASE II PERMIT APPLICATION
CHESAPEAKE TERRACE RUBBLE LANDFILL
PATUXENT ROAD, ODENTON
ANNE ARUNDEL COUNTY, MARYLAND

1055 ANDREW DRIVE, SUITE A, WEST CHESTER PA, 19380
tel 610.840.9100 fax 610.840.9199 www.advancedgeoservices.com

REGIONAL TOPOGRAPHIC PROFILES

REPORT CODE:	A	FILE NAME:	20183854A002
PROJECT MANAGER:	VEF	SCALE:	N.T.S.
CHECKED BY:	VEF	PROJECT NUMBER:	2018–3854
DRAWN BY:	EEE	DATE:	4/1/2019

FIGURE 2

SECTION 4

GROUNDWATER SEPARATION

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4.0 GROUNDWATER SEPARATION

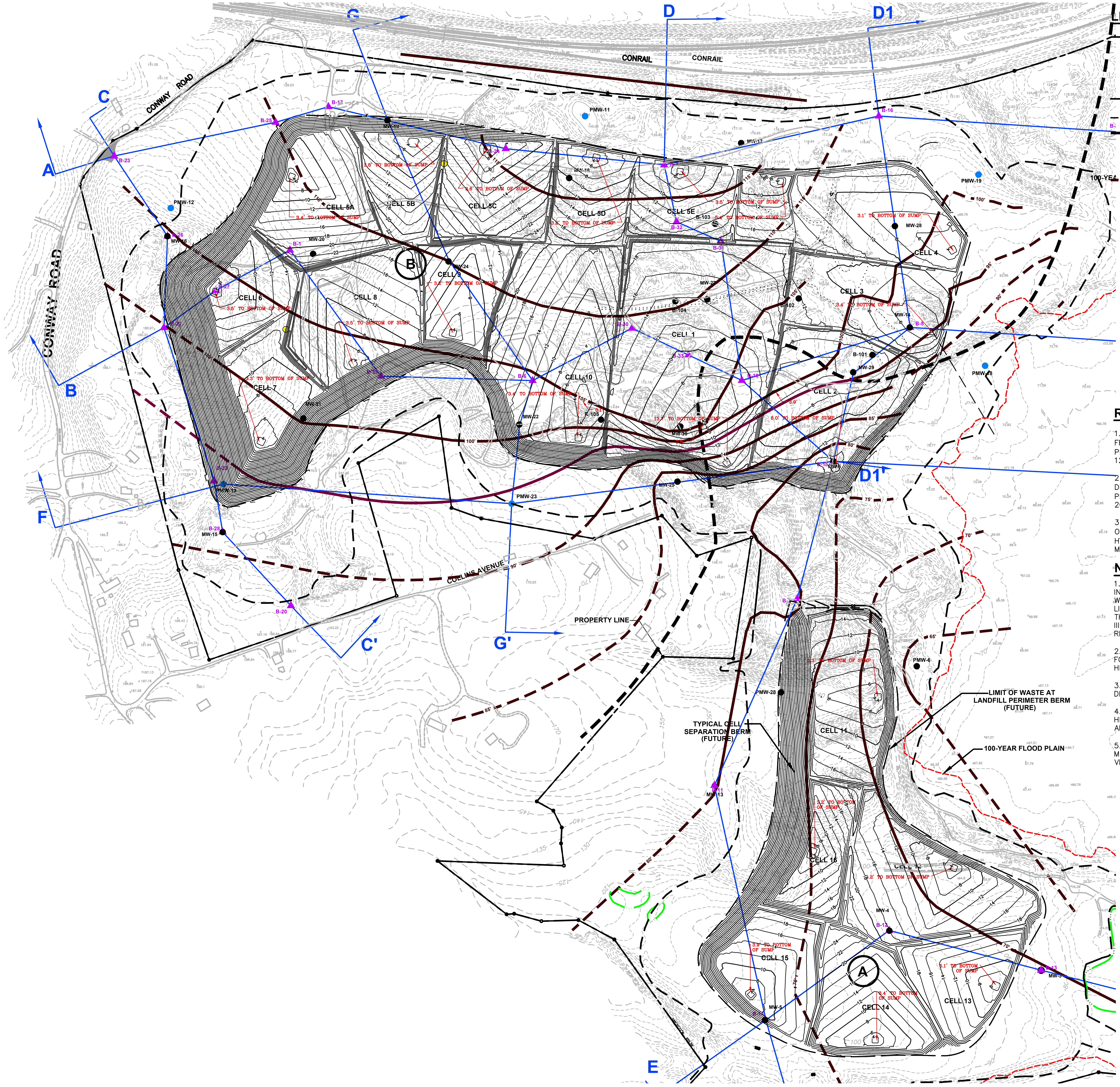
COMAR 26.04.07.16C(6)(a) specifies that “the liner system shall be located entirely above the composite high groundwater elevation.” It further requires there must be minimum 3 feet distance between “maximum expected groundwater elevation” and “bottom of the liner system, including the subbase.”

Drawings 6 and 7 present the Bottom of of Subbase grades ffor the west and east sections, respectively. Figure 12 of the Phase II Permit Application (included in Attachment 4A) represents “highest observed/predicted groundwater condition – unconfined zone.” Comparing these two surfaces provides the isopach map (Figure 4-1) representing the distance between these surface. At all locations, the isopach map shows a minimum distance of at least 3 feet.

It should be noted that the grades shown on Drawings 6 and 7have a minimum constructed slope of three percent (3%) to account for differential settlement over the life of the landfill, so that after placement of waste, minimum floor grades will remain at two percent (2%) or greater. For further discussion about differential settlement, please consult Section 9.

During construction stakeout for the bottom of the subbase beneath the sump, the bottom of subbase elevations shown in tabular form on Drawings 6 and 7 should be laid out first. All subsequent stakeout should be performed relative to the bottom of subbase beneath the sump and utilizing the leachate collection sump configuration on Drawing 19.

FIGURE



UNCONFINED HIGHEST OBSERVED GROUNDWATER LEVELS COMPARED TO CELL BOTTOM GRADE

LEGEND

— - —	PROPERTY LINE
▬	LANDFILL PERIMETER ACCESS ROAD (FUTURE)
▬	SITE ENTRANCE (FUTURE)
— — —	LANDFILL LIMITS (FUTURE)
- - - -	LIMIT OF DISTURBANCE (FUTURE)
▬ ▬ ▬	HYDROGEOLOGIC AREA DIVIDE (SEE REFERENCE 2)
Ⓐ	HYDROGEOLOGIC AREA (SEE REFERENCE 2)
▬ ▬ ▬	ISOPACH LINES

REFERENCES

1.) BASEMAP SHOWN, INCLUDING TOPOGRAPHICAL INFORMATION, IS FROM DIGITAL FILE (2 OF 68) SITE PLAN.DWG, ENTITLED "SITE PLAN," PREPARED BY CENTURY ENGINEERING, INC., DATED APRIL 12, 2010.

2.) MONITORING WELL LOCATIONS DIGITIZED FROM HARD COPY OF DRAWING ENTITLED "PERMANENT GROUNDWATER MONITORING WELL PLAN," PREPARED BY CENTURY ENGINEERING, INC., DATED MAY 2008.

3.) ADDITIONAL HISTORICAL BORING LOCATIONS FROM HARD COPY OF DRAWING ENTITLED "PLATE 2, CHESAPEAKE RUBBLE LANDFILL HYDROGEOLOGIC BASE MAP," DATED NOVEMBER 2003, CREATED BY MARK SCHULTZ ASSOCIATES, ANNAPOLIS, MARYLAND.

NOTES

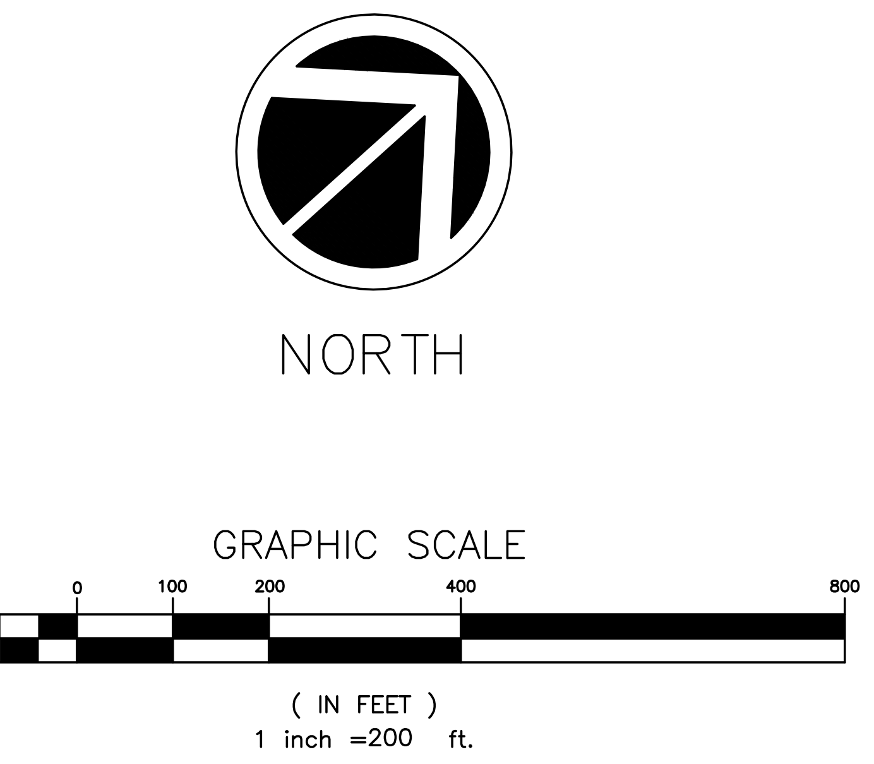
1.) THE FUTURE RUBBLE LANDFILL DEVELOPMENT FEATURES ARE INCLUDED TO SHOW LOCATION OF THE BORINGS AND MONITORING WELLS RELATIVE TO THE PROPOSED DEVELOPMENT. THE ACTUAL LIMITS OF FUTURE DEVELOPMENT MAY BE ADJUSTED AS PART OF THE DETAILED ENGINEERING DESIGN TO BE INCLUDED IN THE PHASE III PERMIT APPLICATION; WHICH IS CURRENTLY UNDERGOING REVISION.

2.) HYDROLOGIC AREAS AND THEIR MAPPING IS BASED ON FORMATIONS MAPPED IN FIELD BOREHOLES, SURFACE OBSERVATION, HISTORICAL AERIAL PHOTOGRAPHS, AND REGIONAL GEOLOGIC MAPS.

3.) THE 100-YEAR FLOODPLAIN LIMITS AND ASSOCIATED DEVELOPMENT PERMITTING HAS BEEN DEVELOPED BY OTHERS.

4.)THE CONRAIL TRACKS ARE ALSO SHARED WITH AMTRAK FOR HIGH-SPEED COMMUTER TRAINS BETWEEN BOSTON, MASSACHUSETTS AND WASHINGTON, D.C.

5.) THE PROPERTY WAS PREVIOUSLY USED FOR SAND AND GRAVEL MINING ACTIVITIES. PORTIONS OF THE SITE CURRENTLY HAVE NO VEGETATION AND ARE BARREN.



DATE:	REVISION:
9/03/2021	REVISED TO ADDRESS MDE COMMENTS ON PHASE 3

NATIONAL WASTE MANAGERS
PHASE III APPLICATION
CHESAPEAKE TERRACE RUBBLE LANDFILL
PATUXENT ROAD, ODENTON
ANNE ARUNDEL COUNTY, MARYLAND

ADVANCED GeoServices
a Montrose Environmental Group company
1878 MARLTON PIKE EAST, SUITE 10, CHERRY HILL, NJ 08003
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LANDFILL BOTTOM GRADES
COMPARED WITH HIGHEST
OBSERVED/ PREDICTED
GROUNDWATER LEVELS

PROJECT MANAGER: PGS	SCALE: AS NOTED
CHECKED BY: PGS	PROJECT NUMBER: 2018 – 3854
DRAWN BY: KHF	DATE: 09/03/2021

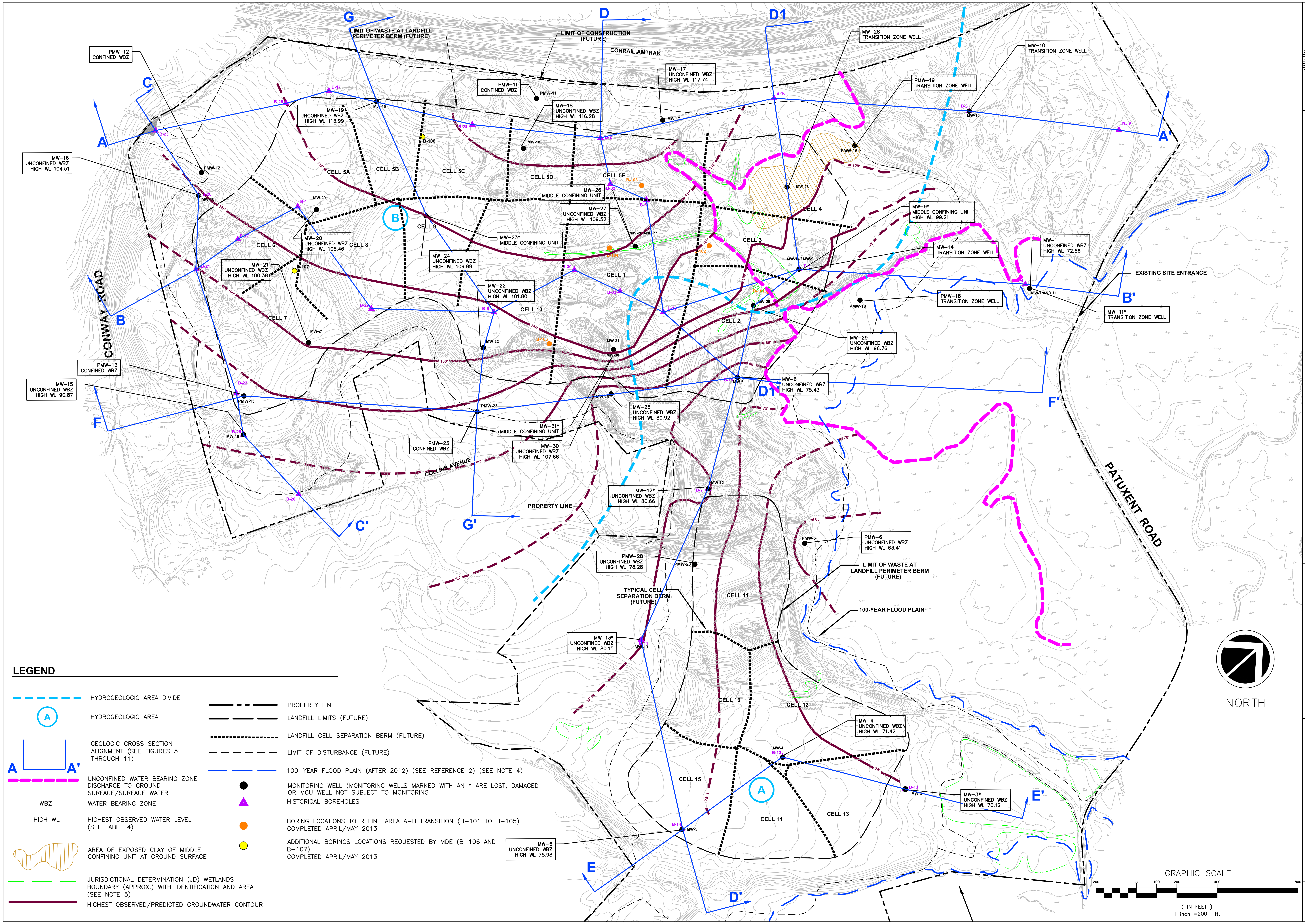
FIGURE 4–1

N:\Projects\2018\20183854 - Chesapeake Terrace LF\CAD\DWG\RC B_Phase III Application\20183854B04-1 - Bottom Cell vs HGW.dwg

ADVANCED GeoServices
a Montrose Environmental Group company

ATTACHMENT 4A

Highest Observed/Predicted Groundwater Contour Map
(from Phase II Permit Application)



LEGEND

▬ ▬ ▬	HYDROGEOLOGIC AREA DIVIDE
Ⓐ	HYDROGEOLOGIC AREA
A ⊔ A'	GEOLOGIC CROSS SECTION ALIGNMENT (SEE FIGURES 5 THROUGH 11)
▬ ▬ ▬	UNCONFINED WATER BEARING ZONE DISCHARGE TO GROUND SURFACE/SURFACE WATER
WBZ	WATER BEARING ZONE
HIGH WL	HIGHEST OBSERVED WATER LEVEL (SEE TABLE 4)
▨	AREA OF EXPOSED CLAY OF MIDDLE CONFINING UNIT AT GROUND SURFACE
— ·· —	JURISDICTIONAL DETERMINATION (JD) WETLANDS BOUNDARY (APPROX.) WITH IDENTIFICATION AND AREA (SEE NOTE 5)
▬▬	HIGHEST OBSERVED/PREDICTED GROUNDWATER CONTOUR

— - —	PROPERTY LINE
— — —	LANDFILL LIMITS (FUTURE)
▪▪▪▪▪▪	LANDFILL CELL SEPARATION BERM (FUTURE)
- - - -	LIMIT OF DISTURBANCE (FUTURE)
— — —	100–YEAR FLOOD PLAIN (AFTER 2012) (SEE REFERENCE 2) (SEE NOTE 4)
●	MONITORING WELL (MONITORING WELLS MARKED WITH AN * ARE LOST, DAMAGED OR MCU WELL NOT SUBJECT TO MONITORING
▲	HISTORICAL BOREHOLES
●	BORING LOCATIONS TO REFINE AREA A–B TRANSITION (B–101 TO B–105) COMPLETED APRIL/MAY 2013
●	ADDITIONAL BORINGS LOCATIONS REQUESTED BY MDE (B–106 AND B–107) COMPLETED APRIL/MAY 2013

VERONICA FOSTER
No. 35645

DATE:	REVISION:
4/30/2020	REVISED TO ADDRESS MDE COMMENTS (PGS/VEF)
6/5/2020	EDITORIAL REVISIONS/NEW LANDFILL BOTTOM (PGS/VEF)

NATIONAL WASTE MANAGERS
PHASE II PERMIT APPLICATION
CHESAPEAKE TERRACE RUBBLE LANDFILL
PATUXENT ROAD, ODENTON
ANNE ARUNDEL COUNTY, MARYLAND

a Montrose Environmental Group company
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HIGHEST OBSERVED/PREDICTED GROUNDWATER CONDITION– UNCONFINED ZONE

REPORT CODE: A		FILE NAME:	20183854A012
PROJECT MANAGER:	VEF	SCALE:	AS NOTED
CHECKED BY:	VEF	PROJECT NUMBER:	2018–3854
DRAWN BY:	EEE	DATE:	7/31/2019

FIGURE 12

SECTION 5

LANDFILL DESIGN LIFE

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5.0 LANDFILL DESIGN LIFE

5.1 Landfill Air Space Estimate

Available area for rubble waste disposal consists of approximately 114.4 acres, as measured at the inside top of berm. AutoCAD computer software was used to estimate total landfill air space between Top of the Leachate Collection System Contours (shown on Drawings 17 and 18) and Top of Waste Contours (shown on Drawings 30and 31). The total gross volume available between these two surfaces is 9.3 million cubic yards (MCY).

5.2 Landfill Life Expectancy

Total available landfill airspace between Top of the Leachate Collection System and Top of Waste surfaces is approximately 9.3 MCY of compacted fill material. This volume includes intermediate and periodic cover. Assuming ten percent (10%) of the total waste disposal volume is intermediate and periodic cover, the net waste disposal volume is 8.38MCY.

The Owner anticipates 1,602 tons per day rubble waste placement, at an average unit rate of 44.0 lbs/cf during a 5 -day per week operational time frame. At this rate, one 8-ft thick lift over 1 acre will provide 4.8 days of disposal. The average daily waste placement rates are based on a 12 year operating life, See the calculation and summary Table A in Attachment 5B.

There will be time associated with construction of the landfill and closure of the landfill which falls outside this 12 year operating life.

We currently anticipate the initial roadways, leachate storage tanks, cells, interior roads, and stormwater management features will take up to two years to construct. After final landfill grades are achieved, COMAR 26.04.07.21C requires closure construction to begin within 24 months of the placement of the final lift of waste and completion of closure cap construction within 36 months of the placement of the final lift.

While we anticipate phased closure cap construction, as areas achieved top of waste filling grades, there may still be a substantial area (20+ acres) requiring final closure cap construction after placement of the final lift of waste. A closure cap can readily be constructed over an area of 20 acres within the required 36 months following placement of the final lift, with favorable weather and adequate borrow sources for cover soils.

Thus, the total duration of construction activities at site are anticipated to be as follows:

• Initial Construction	2 years (or less)
• Landfilling and cell construction concurrently	12 years
• Closure Cap construction	3 years (or less)
Total Construction Timeline =	17 years (or less)

ATTACHMENT 5A

Landfill Airspace Estimate

ADVANCED GeoServices
a Montrose Environmental Group company

Subject: Available Airspace (Waste Disposal Volume)		
Job No. 2018-3854	**Made by:** VEF	**Date** 07-03-20 REV: 08-25-21
Ref.	**Checked by:** JCA REV By PGS	**Sheet** 1 of 2

Objective: The objective of this analysis is to estimate the total waste disposal volume, or airspace.

Design Approach and Assumptions:

The volume of disposal is based primarily on the total area of the landfill and the grading plans representing the Top of Leachate Collection Layer and the Proposed Top of Waste. The total volume available between the grading plans provides the total volume.

This design was developed based on the COMAR-required liner system with geomembrane barrier layer, with a thickness of eight (8) feet.

COMAR-required Liner System	Alternate Liner System
• Four feet of Select Waste; • 10 ounce per square yard (oz./s.y.) nonwoven geotextile for layer separation and visual indicator if breached; • Two feet of leachate collection layer, comprised of locally mined sandy soils; • A geocomposite drainage net (GDN), consisting of a tri-planar drainage net with a minimum 8 oz./s.y. nonwoven geotextile heat-bonded to both sides; • geomembrane with a permeability less than or equal to 1 x 10^{-10} cm/sec; and; • Prepared subbase with a minimum thickness of 2 feet and having a permeability less than or equal to 1.0 x 10^{-5} cm/sec.	• Eliminated from calculation
Total Thickness – 8 feet	

The final cover system is comprised of the following components, with a total thickness of 4 feet:

- 6-inch thick layer of vegetative support layer (topsoil or other material capable of supporting vegetation);
- 18-inches of protective cover soils, with a permeability not exceeding 1x10^{-5} cm/sec;
- A geocomposite drainage layer, with a tri-planar drainage net and 8 oz./s.y. nonwoven geotextile heat-bonded to both sides; and,
- 40-mil textured on both sides, linear low density polyethylene (LLDPE) geomembrane with a permeability less than or equal to 1 x 10^{-10} cm/sec.
- 24-inch thick Final Cover Soil Layer

ADVANCED GeoServices a Montrose Environmental Group company	**Subject:** Available Airspace (Waste Disposal Volume)		
	Job No. 2018-3854	**Made by:** VEF	**Date** 07-03-20 REV: 08-25-21
	Ref.	**Checked by:** JCA REV By PGS	**Sheet** 2 of 2

Calculations:

Based on the two grading plans, using the Civil3D tools in AutoCAD, determine the total volume between the final cover grading plan and the subbase grading plan for the west and east sections. Also, using the area function in AutoCAD, determine the total area of each section.

Landfill Section	**West (Cells 1-10)**	**East (Cells 11-16)**
Volume (cubic yards)	7,247,000	2,065,000
Total Volume (cubic yards)	9.31M	
Area (square feet)	3,649,585	1,335,004
Area (acres)	83.8	30.6
Waste Disposal Volume (cubic yards) (including Intermediate and Final cover)	**9,312,000 c.y.**	
Assume 10% for Int/Final Cover	**0.93 M c.y.**	
Waste Disposal Volume (tonnage)	**(8.38 M c.y. x 1188 lb/c.y.)/2000 ~ 5.0 M tons**	
Average Daily intake (assuming 5.0 days/week and 52 weeks per year operation for 12 years)	**5.0 M/(12 x 5.0 x 52) = 1,602 tons/day**	

Conclusions:

Based on the foregoing, the total waste disposal volume for the proposed Chesapeake Terrace Rubble Landfill is 8.38 M c.y., or 5.0 M tons, excluding intermediate and periodic cover.

References:

1. Advanced GeoServices Corp., "Top of Leachate Collection Layer Grading Plan – West Section," dated August 26, 2021.
2. Advanced GeoServices Corp., "Top of Leachate Collection Layer Grading Plan – East Section," dated August 26, 2021.
3. Advanced GeoServices Corp., "Top of Waste Grading Plan – West Section," dated August 26, 2021
4. Advanced GeoServices Corp., "Top of Waste Grading Plan – East Section," dated August 26, 2021.
5. Advanced GeoServices Corp, Calculation "Waste Density," dated June 23, 2020.

ATTACHMENT 5B

Cell Life Summary

Attachement 5B - Cell Life Summary

ADVANCED GeoServices a Montrose Environmental Group company	**Subject:** Landfill Life		
	Job No. 2018-3084	**Made by:** JCA	**Date** 7/1/20
	Ref.	**Checked by:** VEF	**Sheet** 1 **of 2**

Revised by PGS 08-26-2021

1. Purpose

The purpose of these calculations is to estimate the disposal life of each cell of the landfill. This data is to be used in the leachate generation modeling.

2. Analysis Approach and Assumptions

The elevations of the center of the Top of Leachate Collection Layer and Top of Waste were estimated. Based on the difference in these elevations, the average thickness of the waste layer in each cell was calculated.

The waste will be placed in each cell in **8-ft** thick lifts. Therefore, the thickness of each cell was also calculated in terms of the number of **8-ft** lifts.

The area of certain elevations in each cell was measured with a digital planimeter. These areas were then used in an end-area calculation to estimate the volume bounded by the top of the completed landfill (final elevations), the bottom of the cell (base grades), and the vertical division between each cell. Each cell volume was compared to its respective area, and an average height was calculated.

Using the planned waste acceptance rate of 1,602 tons/day, and a waste density of 0.598 ton/cy (1,196 pcy), a cell life was calculated.

This data was used to estimate the total landfill life, and to establish modeling parameters for leachate generation.

The attached table entitled “Cell Life Estimates” provides a summary of this data.

3. Calculations

Notes:

1. Avg waste thickness = Avg Top of Waste contour minus top of leachate collection layer
2. Parameters: 0.573 ton/cy; 1,602 tons/day; 5.0 days/week; 52 weeks/year; 12 months/year.

Objective: Estimate the life of an 8-ft lift on a unit 1-acre of cell area

Given: $\gamma = 44.0$ pcf ; 1,602 Tons ~~2684 tons~~/day

Calculation:

$$\frac{\left(8\,\frac{ft}{lift}\right)(43{,}560\ ft^2)(44.0\ \#/ft^3)}{2000\ \#/ton} = 7666\ T/lift$$

$$\frac{7666\ T/lift}{\underset{\text{1,602 Tons}}{\cancel{2686}}\ T/day} = \overset{4.8}{\cancel{2.8}}\ \frac{days/lift}{ac}$$

SHEET 1 OF 1 PROJECT NO. 2018-3084 PROJECT NAME

BY JCA DATE 6/27/20 DESCRIPTION Disposal life of one

CHK. BY VEJ DATE 7/15/20 8-ft lift Revised by PGS 08-26-2021

Table A - Cell Life Estimates

Cell	*Total Cell Area (ac)*	*Avg. Top of Waste Elevation (ft)*	*Avg. Top of LCL Elevation (ft)*	*Avg. Waste Thickness (ft)*	*Avg. Number of 8-ft Lifts (ea)*	*HELP [2] Number of 8-ft Lifts (ea)*	*Estimated Cell Life [3] (months)*	*Cell Life [4] (months)*
1	13.2	236	120	116	14.5	15	24.2	24
2	7.5	184	104	80	10.0	10	8.4	8
3	4.9	206	113	93	11.6	12	5.4	5
4	5.5	170	117	53	6.6	7	4.3	4
5A	5.6	220	126	94	11.8	12	7.7	8
5B	3.4	208	128	80	10.0	10	3.6	4
5C	4.4	194	130	64	8.0	8	4.2	4
5D	2.9	186	130	56	7.0	7	2.1	2
5E	3.2	172	129	43	5.4	5	2.3	2
5F	1.7	172	128	44	5.5	6	1.6	2
6	5.2	220	118	102	12.8	13	9.7	10
7	6.7	230	112	118	14.8	15	11.8	12
8	6	220	120	100	12.5	13	9.2	9
9	4	220	120	100	12.5	13	5.7	6
10	9.6	236	122	114	14.3	14	14.8	15
11	7	144	84	60	7.5	8	7.9	8
12	6.7	140	87	53	6.6	7	5.0	5
13	3.4	138	87	51	6.4	6	2.9	3
14	4.3	156	89	67	8.4	8	3.5	4
15	4.7	166	91	75	9.4	9	4.7	5
16	4.5	178	90	88	11.0	11	5.5	6
Total	114.4					***Total Months***	144.5	144.0
						Total Years	12.0	12.0

ATTACHMENT 5C

Waste Density

ADVANCED GeoServices A Montrose Environmental Group company	**Subject:** Waste Density	
	Job No. 2018-3084	**Made by: JCA** **Date** 07-05-20
	Ref.	**Checked by: VEF** Sheet 1 of 2

Revised by PGS 08-26-2021

Objective:

The objective of this analysis is to establish the density of the construction, demolition, and debris (CDD) waste for the landfill. This data is used in various other design calculations.

Design Approach and Assumptions:

The CDD density was initially estimated from the historical values of other CDD (rubble) landfills in the state based on the annual *"Maryland Solid Waste Management and Diversion Report"* (MSWDR) for the available calendar years (CY) 2011 through 2016.

The MSWDR included data associated with 5 rubble landfills in the state. Three of these landfills reported annual waste tonnage accepted for landfilling, and the volume used for landfilling. It is presumed these volumes included soil materials used for weekly cover. A fourth landfill reported data that seemed to be based on an assumed waste density. A fifth landfill reported accumulative data rather than annual data. The data from these two latter landfills was not used in this analysis.

Based on the data considered, a CDD waste density was established for this design. It is recognized this density does not include the weight of the soil used for weekly cover since only the weight of waste accepted for landfilling was reported. Therefore, the density established from the MSWDMR data will be used for life calculations only. A density that includes the weight of soil for weekly cover is calculated for use in various calculations that consider the vertical weight or stress due to the CDD waste.

Calculations:

As indicated, the CDD density was initially estimated from the proposed operational conditions, as follows:

The *"Maryland Solid Waste Management and Diversion Report"* (MSWMDR) for the available CY 2011 through CY 2016 for the Baker Rubble Landfill, the Days Cove Rubble Landfill, and the Honeygo Run Reclamation Center was reviewed. From this data, the CDD density in these three rubble landfills has ranged from 534 pcy to 1,547 pcy, with an average 1,187.7 pcy (44.0 pcf). This density is used for life calculations for each cell.

A summary table and copies of the MSWMDR data are attached.

From the cell life calculations, it is estimated a 1 acre area will be filled with one 8-ft lift of waste in 4.8 days. This would result in 1 acre of waste, 8-ft thick, would be placed in one operating week (5.0 days). It is estimated this 1-acre area and volume would total approximately 7,665 tons of waste. Weekly cover would comprise 0.5-Ft of soil over the 1-acre area. Based on a "loose spread" density of 75 pcf, the weekly cover soil would be approximately 817 tons. Considering the CDD waste typically has far more void space than that of municipal solid waste, it is assumed the weekly cover soil will eventually ravel vertically downward into the underlying CDD waste. Therefore, the weekly cover soil will not affect the volume and life analysis, but will result in an increased density of the landfilled CDD waste. This increased density is estimated to be 48.7 pcf.

A calculation of the increased waste density is attached.

Conclusions:

Based on the foregoing, the following conclusions are presented:

1. A CDD waste density of 44.0 pcf can be used for the calculations of the disposal life of each cell.
2. A CDD waste density of 48.7 pcf can be used for various calculations where the vertical stress or weight of the CDD waste is considered.

References:

1. Maryland Department of the Environment; "*Maryland Solid Waste Management and Diversion Report*"; 2012 (CY 2011) through 2017 (CY 2016).

2. Project airspace and life analysis.

Summary of Maryland Solid Waste Management and Diversion Report for Calendar Years 2011 through 2016

Baker Rubble Landfill

Quantity	CY 2011	CY 2012	CY 2013	CY 2014	CY 2015	CY 2016	Average
Landfilled in CY (cy)	18,314	27,218	30,978	30,052	30,730	33,560	
Landfilled in CY (tons)	12,762	13,403	15,489	16,124	16,288	17,788	
Landfilled Density in CY (tcy)	*0.6968*	*0.4924*	*0.5000*	*0.5365*	*0.5300*	*0.5300*	
Landfilled Density in CY (pcy)	***1,394***	***985***	***1,000***	***1,073***	***1,060***	***1,060***	***1,095***

Days Cove Rubble Landfill

Quantity	CY 2011	CY 2012	CY 2013	CY 2014	CY 2015	CY 2016	Average
Landfilled in CY (cy)	199,357	204,141	208,515	146,409	325,301	321,838	
Landfilled in CY (tons)	119,891	122,022	123,717	113,219	183,123	186,566	
Landfilled Density in CY (tcy)	*0.6014*	*0.5977*	*0.5933*	*0.7733*	*0.5629*	*0.5797*	
Landfilled Density in CY (pcy)	***1,203***	***1,195***	***1,187***	***1,547***	***1,126***	***1,159***	***1,236***

Honeygo Run Reclamation Center

Quantity	CY 2011	CY 2012	CY 2013	CY 2014	CY 2015	CY 2016	Average
Landfilled in CY (cy)	172,117	205,019	167,002	194,972	248,032	315,279	
Landfilled in CY (tons)	116,111	114,988	103,541	116,983	146,339	204,773	
Landfilled Density in CY (tcy)	*0.6746*	*0.5609*	*0.6200*	*0.6000*	*0.5900*	*0.6495*	
Landfilled Density in CY (pcy)	***1,349***	***1,122***	***1,240***	***1,200***	***1,180***	***1,299***	***1,232***

Average of CDD waste density as compacted in the landfill: 1,187.7 pcy = 44.0 pcf

'12 MSWMDR (CY 2011)

Construction and Demolition Debris landfills (Table 17) reported a total available capacity of 13,132,862 tons with 525,684 tons disposed in CY 2011. At the current disposal rate, there would be approximately 25 years (13,132,862 tons ÷ 525,684 tons) of available C&D landfill capacity in Maryland.

Table 17 – C&D Landfill Capacity

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2011 (CY)	Landfilled in 2011 (Tons)	Used in 2011 ^
Baker Rubble Landfill	820,000	542,754	317,989	277,246	117,001	2022	18,314	12,762	2.23%
Days Cove Rubble Landfill – Lateral Expansion	3,200,000	1,671,904	1,020,440	1,528,096	1,139,560	2018	199,357	119,891	6.23%
Honeygo Run Reclamation Center	11,723,461	3,998,393	2,785,249	7,725,068	4,381,600	2048	172,117	116,111	1.47%
Ritchie Land Reclamation Partnership Phase I & II	7,255,800	697,799	697,799	6,558,001	6,477,214	2052	276,921	276,920	3.82%
Washington County Rubble Landfill	2,201,664	166,690	83,345	2,034,974	1,017,487	2061	0	0	0.00%
TOTALS	**25,200,925**	**7,077,540**	**4,904,832**	**18,123,385**	**13,132,862**		**666,709**	**525,684**	**2.65%**

^ Equal to Landfilled in 2011 (CY) ÷ Permitted Capacity (CY)

Industrial landfills (Table 18) reported a total available capacity of 6,399,571 tons. At a current disposal rate of 39,728 tons/year (1,614,460 tons not included in the tons/year disposal rate calculation. See Industrial Waste Landfill section on Page 8, for details), there would be approximately 161 years (6,399,571 tons ÷ 39,728 tons) of available industrial landfill capacity in Maryland.

Table 18 – Industrial Landfill Capacity

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2011 (CY)	Landfilled in 2011 (Tons)	Used in 2011 ^
W.R. Grace and Co. – Davison Chemical Division	495,000	102,503	106,892	392,497	409,304	2027	23,887	24,910	4.83%
Eastalco Aluminum Company	380,000	79,517	109,256	300,483	412,864	2050	0	0	0.00%
Millennium Inorganic Chemicals – HPP Landfill	7,293,378	2,279,841	3,813,323	5,013,537	5,577,403	2019	1,013,299	1,629,278	13.89%
TOTALS	**8,168,378**	**2,461,861**	**4,029,471**	**5,706,517**	**6,399,571**		**1,037,186**	**1,654,188**	**12.70%**

^ Equal to Landfilled in 2011 (CY) ÷ Permitted Capacity (CY)

Landclearing Debris landfills (Table 19) reported a total available capacity of 152,616 tons with 2,312 tons disposed in CY 2011. At the current disposal rate, there would be approximately 66 years (152,616 tons ÷ 2,312 tons) of available landclearing debris landfill capacity in Maryland.

Table 19 – Landclearing Debris Landfill Capacity

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2011 (CY)	Landfilled in 2011 (Tons)	Used in 2011 ^
Howlin Landclearing Debris Landfill	64,120	44,184	55,230	19,936	24,920	2016	1,740	2,175	2.71%

'13 MSWMDR(CY2012)

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2012 (CY)	Landfilled in 2012 (Tons)	Used in 2012 ^
Harford Waste Disposal Center	2,980,000	2,884,800	1,114,583	95,200	65,680	2017	20,860	18,772	0.70%
Harford Waste Disposal Center (Expansion)	4,870,330	215,739	72,098	4,654,591	2,059,202	2028	142,451	58,622	2.92%
Midshore Regional Solid Waste Facility	3,924,994	3,684,695	2,032,481	240,299	126,246	2015	0	0	0.00%
Midshore II Regional Solid Waste Facility	7,800,000	506,539	246,498	7,293,461	4,433,502	2063	190,159	109,914	2.44%
Millersville Landfill & Resource Recovery Facility	14,156,000	4,898,241	3,093,579	9,257,759	5,400,021	2041	154,688	71,405	1.09%
Montgomery County Site 2**	0	0	0	0	0	N/A	0	0	0
Mountainview Sanitary Landfill	4,260,000	3,427,873	2,339,437	832,127	515,919	2022	92,936	80,991	2.18%
Newland Park Municipal Landfill	7,200,000	2,840,541	1,533,892	4,359,459	2,354,108	2038	169,455	91,506	2.35%
Northern Municipal Landfill	3,504,187	1,139,281	569,641	2,364,906	1,182,453	2059	25,700	12,850	0.73%
Quarantine Road Landfill	18,320,622	13,038,537	15,255,140	5,282,085	6,180,042	2026	295,686	153,321	1.61%
Reichs Ford/Site B Municipal Sanitary Landfill	7,326,426	3,621,309	2,036,986	3,705,117	2,084,129	2045	47,506	26,722	0.65%
St. Andrews Municipal Landfill*	1,500,000	0	0	1,500,000	750,000	2034	0	0	0
Somerset County Landfill – Fairmount Site	1,610,000	704,443	412,451	905,557	381,279	2026	41,586	24,371	2.58%
Totals	**179,180,140**	**81,430,481**	**54,558,415**	**97,749,659**	**54,841,974**		**2,637,959**	**1,510,570**	**1.47%**

* St. Andrews Landfill closed in 2001 (Permit No. 2000-WMF-0138). The current permit was issued for a new landfill that was never constructed. St. Mary's County uses permit 2005-WMF-0138 to operate the closed St. Andrews Landfill as a transfer station.

** Montgomery County Site 2 Landfill's construction is on hold until the County needs landfill space in the future.

^ Equal to Landfilled in 2012 (CY) ÷ Permitted Capacity (CY)

Construction and Demolition Debris landfills (Table 17) reported a total available capacity of 12,751,863 tons with 511,755 tons disposed in CY 2012. At the current disposal rate, there would be approximately 25 years (12,751,863 tons ÷ 511,755 tons) of available C&D landfill capacity in Maryland.

Table 17 – C&D Landfill Capacity

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2012 (CY)	Landfilled in 2012 (Tons)	Used in 2012 ^
Baker Rubble Landfill	820,000	569,972	331,402	250,028	103,598	2020	27,218	13,403	3.32%
Days Cove Rubble Landfill – Lateral Expansion	3,200,000	1,876,045	1,142,463	1,323,955	1,017,537	2019	204,141	122,022	6.38%
Honeygo Run Reclamation Center	11,723,461	4,149,626	2,900,237	7,573,835	4,266,612	2050	205,019	114,988	1.75%
Ritchie Land Reclamation Partnership Phase I & II	12,655,800	6,346,629	6,346,629	6,309,171	6,346,629	2040	261,342	261,342	2.06%
Washington County Rubble Landfill	2,201,664	166,690	83,345	2,034,974	1,017,487	2061	0	0	0.00%
TOTALS	**30,600,925**	**13,108,962**	**10,804,076**	**17,491,963**	**12,751,863**		**697,720**	**511,755**	**2.28%**

^ Equal to Landfilled in 2012 (CY) ÷ Permitted Capacity (CY)

Industrial landfills (Table 18) reported a total available capacity of 5,757,976 tons. At a current disposal rate of 392,982 tons, there would be approximately 15 years (5,757,976 tons ÷ 392,982 tons) of available industrial landfill capacity in Maryland.

'14 MSWMDR (CY 2013)

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2013 (CY)	Landfilled in 2013 (Tons)	Used in 2013 ^
Garrett County Solid Waste Disposal & Recycling Facility	2,042,927	1,075,902	632,847	967,025	589,916	2034	48,932	26,064	2.40%
Harford Waste Disposal Center	2,980,000	2,864,795	1,096,578	115,205	103,685	2017	855	767	0.03%
Harford Waste Disposal Center (Expansion)	4,870,330	399,751	169,109	4,470,579	1,952,191	2028	190,400	97,196	3.91%
Midshore Regional Solid Waste Facility	3,924,994	3,684,695	2,032,481	240,299	126,246	2015	0	0	0.00%
Midshore II Regional Solid Waste Facility	7,800,000	693,388	355,341	7,106,612	4,324,659	2053	186,849	101,927	2.40%
Millersville Landfill & Resource Recovery Facility	14,156,000	5,026,935	3,016,161	9,129,065	5,477,439	2043	142,249	66,064	1.00%
Montgomery County Site 2**	0	0	0	0	0	N/A	0	0	0
Mountainview Sanitary Landfill	4,260,000	3,525,108	2,424,204	734,892	375,796	2022	97,236	84,736	2.28%
Newland Park Municipal Landfill	7,200,000	3,017,622	1,629,516	4,182,378	2,258,484	2038	176,081	95,064	2.45%
Northern Municipal Landfill	3,504,187	1,167,576	583,788	2,336,611	1,168,306	2055	28,296	14,147	0.81%
Quarantine Road Landfill	18,320,622	13,324,343	15,589,482	4,996,279	5,845,700	2026	285,763	334,342	1.56%
Reichs Ford/Site B Municipal Sanitary Landfill	7,326,426	3,962,386	2,228,842	3,364,040	1,892,273	2045	41,082	23,108	0.56%
St. Andrews Municipal Landfill*	1,500,000	0	0	1,500,000	750,000	2034	0	0	0
Somerset County Landfill – Fairmount Site	1,610,000	741,163	436,253	868,837	357,477	2026	36,720	23,802	2.28%
Totals	**179,200,140**	**84,576,420**	**56,183,979**	**94,623,720**	**53,439,306**		**2,488,223**	**1,605,424**	**1.39%**

* St. Andrews Municipal Landfill closed in 2001 (Permit No. 2000-WMF-0138). The current permit was issued for a new landfill that was never constructed. St. Mary's County uses permit 2010-WMF-0138 to operate the closed St. Andrews Municipal Landfill as a transfer station.

** Montgomery County Site 2 Landfill's construction is on hold until the county needs landfill space in the future.

^ Equal to Landfilled in 2013 (CY) ÷ Permitted Capacity (CY)

Construction and Demolition Debris landfills (Table 17) reported a total available capacity of 12,202,688 tons with 510,354 tons disposed in CY 2013. At the current disposal rate, there would be approximately 24 years (12,202,688 tons ÷ 510,354 tons) of available C&D landfill capacity in Maryland.

Table 17 – C&D Landfill Capacity

Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2013 (CY)	Landfilled in 2013 (Tons)	Used in 2013 ^
Baker Rubble Landfill	820,000	600,950	346,891	219,050	88,109	2020	30,978	15,489	3.78%
Days Cove Rubble Landfill – Lateral Expansion	3,192,000	2,084,560	1,266,180	1,107,440	893,820	2019	208,515	123,717	6.53%
Honeygo Run Reclamation Center	11,723,461	4,330,058	3,003,778	7,393,403	4,163,071	2049	167,002	103,541	1.42%
Ritchie Land Reclamation Partnership Phase I & II	12,655,800	6,615,599	6,615,599	6,040,201	6,040,201	2040	267,607	267,607	2.11%
Washington County Rubble Landfill	2,201,664	166,690	83,345	2,034,974	1,017,487	2061	0	0	0.00%
TOTALS	**30,592,925**	**13,797,857**	**11,315,793**	**16,795,068**	**12,202,688**		**674,102**	**510,354**	**2.20%**

^ Equal to Landfilled in 2013 (CY) ÷ Permitted Capacity (CY)

'15 MSWMDR (CY2014)

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2014 (CY)	Landfilled in 2014 (Tons)	Used in 2014 ^
Forty West Municipal Landfill	24,762,000	4,087,906	1,634,537	20,664,094	7,956,863	2119	155,182	78,800	0.67%
Garrett County Solid Waste Disposal & Recycling Facility	2,568,470	1,124,191	659,419	1,444,279	831,136	2042	48,289	25,630	1.88%
Harford Waste Disposal Center	2,980,000	2,968,000	1,096,578	12,000	10,000	2017	0	0	0.00%
Harford Waste Disposal Center (Expansion)	4,870,330	540,751	252,945	4,329,579	1,991,606	2037	141,000	83,736	2.90%
Midshore Regional Solid Waste Facility	3,924,994	3,684,695	2,032,481	240,299	126,246	2010	0	0	0.00%
Midshore II Regional Solid Waste Facility	7,800,000	865,252	458,459	6,934,748	4,221,541	2055	171,864	101,911	2.20%
Millersville Landfill & Resource Recovery Facility	14,156,000	5,138,330	3,092,941	9,017,670	5,400,659	2043	146,121	76,780	1.03%
Montgomery County Site 2**	0	0	0	0	0	N/A	0	0	0
Mountainview Sanitary Landfill	3,971,631	3,559,625	2,509,535	412,006	290,364	2022	121,038	85,332	3.05%
Newland Park Municipal Landfill	7,200,000	3,383,281	1,826,972	3,816,719	2,061,028	2035	182,830	98,728	2.54%
Northern Municipal Landfill	3,504,187	1,199,391	599,696	2,304,796	1,152,398	2055	31,816	15,908	0.91%
Quarantine Road Landfill	18,320,622	13,423,921	15,928,627	4,896,701	5,506,555	2028	348,836	323,640	1.90%
Reichs Ford/Site B Municipal Sanitary Landfill	7,326,426	3,981,331	2,239,500	3,345,095	1,881,615	2045	31,073	17,479	0.42%
St. Andrews Municipal Landfill*	1,500,000	0	0	1,500,000	750,000	2034	0	0	0
Somerset County Landfill – Fairmount Site	1,610,000	782,913	458,457	827,087	335,273	2026	41,760	22,203	2.59%
Totals	**180,313,173**	**86,649,108**	**57,917,684**	**93,664,065**	**52,135,583**		**2,603,930**	**1,653,932**	**1.44%**

* St. Andrews Municipal Landfill closed in 2001 (Permit No. 2000-WMF-0138). The current permit was issued for a new landfill that was never constructed. St. Mary's County uses permit 2010-WMF-0138 to operate the closed St. Andrews Municipal Landfill as a transfer station.

** Montgomery County Site 2 Landfill's construction is on hold until the county needs landfill space in the future.

^ Equal to Landfilled in 2014 (CY) ÷ Permitted Capacity (CY)

Construction and Demolition Debris landfills (Table 17) reported a total available capacity of 11,743,963 tons with 495,757 tons disposed in CY 2014. At the current disposal rate, there would be approximately 24 years (11,743,963 tons ÷ 495,757 tons) of available C&D landfill capacity in Maryland.

Table 17 – C&D Landfill Capacity

Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2014 (CY)	Landfilled in 2014 (Tons)	Used in 2014 ^
Baker Rubble Landfill	820,000	631,002	363,015	188,998	71,985	2020	30,052	16,124	3.66%
Days Cove Rubble Landfill – Lateral Expansion	3,192,000	2,230,969	1,379,399	961,031	760,601	2020	146,409	113,219	4.59%
Honeygo Run Reclamation Center	11,723,461	4,537,762	3,120,761	7,185,699	4,046,088	2049	194,972	116,983	1.66%
Ritchie Land Reclamation Partnership Phase I & II	12,655,800	6,827,998	6,827,998	5,827,802	5,827,802	2042	249,431	249,431	1.97%
Washington County Rubble Landfill	2,201,664	166,690	83,345	2,034,974	1,017,487	2061	0	0	0.00%
TOTALS	**30,592,925**	**14,394,421**	**11,774,518**	**16,198,504**	**11,743,963**		**620,864**	**495,757**	**2.03%**

^ Equal to Landfilled in 2014 (CY) ÷ Permitted Capacity (CY)

'16 MSWMDR(CY 2015)

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2015 (CY)	Landfilled in 2015 (Tons)	Used in 2015 ^
Garrett County Solid Waste Disposal & Recycling Facility	2,568,470	1,176,087	688,038	1,392,383	790,974	2041	51,896	28,619	2.02%
Harford Waste Disposal Center	2,980,000	2,864,795	1,096,578	115,205	103,685	2017	0	0	0.00%
Harford Waste Disposal Center (Expansion)	4,870,330	748,375	314,834	4,121,955	1,816,456	2043	207,624	61,989	4.26%
Midshore Regional Solid Waste Facility	3,924,994	3,684,695	2,032,481	240,299	126,266	2010	0	0	0.00%
Midshore II Regional Solid Waste Facility	7,800,000	1,073,251	570,397	6,726,749	4,109,603	2052	207,999	111,938	2.67%
Millersville Landfill & Resource Recovery Facility	14,156,000	5,260,458	3,156,275	8,895,542	5,337,325	2043	215,524	107,315	1.52%
Montgomery County Site 2**	0	0	0	0	0	N/A	0	0	0
Mountainview Sanitary Landfill	3,971,631	3,666,612	2,584,961	305,019	215,039	2022	107,025	75,426	2.69%
Newland Park Municipal Landfill	7,200,000	3,579,360	1,932,854	3,620,640	1,955,146	2035	196,079	105,882	2.72%
Northern Municipal Landfill	3,504,187	1,212,989	606,494	2,291,198	1,145,599	2071	13,597	6,799	0.39%
Quarantine Road Landfill	18,320,622	13,872,436	16,230,751	4,448,186	5,204,561	2026	258,226	302,125	1.41%
Reichs Ford/Site B Municipal Sanitary Landfill	7,326,426	3,962,386	2,197,070	3,364,040	1,924,045	2045	25,411	14,294	0.35%
St. Andrews Municipal Landfill*	1,500,000	0	0	1,500,000	750,000	2034	0	0	0
Somerset County Landfill – Fairmount Site	1,610,000	827,885	481,360	782,115	312,370	2031	44,972	22,904	2.79%
Totals	**197,113,173**	**88,384,604**	**59,420,465**	**108,728,569**	**60,499,777**		**2,748,897**	**1,691,223**	**1.39%**

* St. Andrews Municipal Landfill closed in 2001 (Permit No. 2000-WMF-0138). The current permit was issued for a new landfill that was never constructed. St. Mary's County uses permit 2015-WMF-0138 to operate the closed St. Andrews Municipal Landfill as a transfer station.

** Montgomery County Site 2 Landfill's construction is on hold until the county needs landfill space in the future.

^ Equal to Landfilled in 2015 (CY) ÷ Permitted Capacity (CY)

Construction and Demolition Debris landfills (Table 17) reported a total available capacity of 16,054,391 tons with 561,026 tons disposed in CY 2015. At the current disposal rate, there would be approximately 29 years (16,054,391 tons ÷ 561,026 tons) of available C&D landfill capacity in Maryland.

Table 17 – C&D Landfill Capacity

Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2015 (CY)	Landfilled in 2015 (Tons)	Used in 2015 ^
Baker Rubble Landfill	820,000	661,732	379,303	158,268	55,697	2020	30,730	16,288	3.75%
Days Cove Rubble Landfill – Lateral Expansion	3,192,000	2,556,270	1,562,522	635,730	597,478	2018	325,301	183,123	10.19%
Honeygo Run Reclamation Center	11,723,461	4,793,300	3,267,100	6,930,161	3,899,749	2048	248,032	146,339	2.12%
Ritchie Land Reclamation Partnership Phase I & II	12,655,800	7,186,791	7,043,274	5,469,009	3,281,405	2030	358,793	215,276	2.84%
Tolson & Associates	5,762,060	0	0	5,762,060	7,202,575	2035	0	0	0%
Washington County Rubble Landfill	2,201,664	166,690	83,345	2,034,974	1,017,487	2061	0	0	0.00%
TOTALS	**36,354,985**	**15,364,783**	**12,335,544**	**20,990,202**	**16,054,391**		**962,856**	**561,026**	**2.65%**

^ Equal to Landfilled in 2015 (CY) ÷ Permitted Capacity (CY)

'17 MSWMDR (CY 2016)

Municipal Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2016 (CY)	Landfilled in 2016 (Tons)	Used in 2016 ^
St. Andrews Municipal Landfill*	1,500,000	0	0	1,500,000	750,000	2034	0	0	0
Somerset County Landfill – Fairmount Site	1,610,000	870,314	506,193	739,686	287,597	2031	42,429	24,793	2.64%
Totals	**193,507,242**	**88,668,657**	**60,159,089**	**104,838,585**	**58,861,737**		**2,937,754**	**1,710,309**	**1.39%**

* St. Andrews Municipal Landfill closed in 2001. The current permit (2016-WMF-0136) was issued for a new landfill that was never constructed. St. Mary's County uses permit 2015-WMF-0138 to operate the closed St. Andrews Municipal Landfill as a transfer station.

** Montgomery County Site 2 Landfill's construction is on hold until the county needs landfill space in the future.

^ Equal to Landfilled in 2016 (CY) ÷ Permitted Capacity (CY)

Construction and Demolition Debris landfills (Table C2) reported a total available capacity of 13,795,362 tons with 718,514 tons disposed in CY 2016. At the current disposal rate, there would be approximately 19 years (13,795,362 tons ÷ 718,514 tons) of available C&D landfill capacity in Maryland.

Table C2 – C&D Landfill Capacity

Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2016 (CY)	Landfilled in 2016 (Tons)	Used in 2016 ^
Baker Rubble Landfill	820,000	695,292	397,091	124,708	37,909	2020	33,560	17,788	4.09%
Days Cove Rubble Landfill – Lateral Expansion	3,192,000	2,878,108	1,749,088	313,892	410,912	2018	321,838	186,566	10.08%
Honeygo Run Reclamation Center	11,723,461	5,148,882	3,471,873	6,574,579	3,694,976	2042	315,279	204,773	2.69%
Ritchie Land Reclamation Partnership Phase I & II	12,655,800	7,696,515	7,349,108	4,959,285	2,975,571	2025	509,724	305,834	4.03%
Tolson & Associates	5,762,060	3553	3553	5,758,507	5,758,507	2042	3553	3553	0.06%
Washington County Rubble Landfill	2,201,664	166,690	83,345	2,034,974	917,487	2061	0	0	0.00%
TOTALS	**36,354,985**	**16,589,040**	**13,054,058**	**19,765,945**	**13,795,362**		**1,183,954**	**718,514**	**3.26%**

^ Equal to Landfilled in 2016 (CY) ÷ Permitted Capacity (CY)

Industrial landfills (Table C3) reported a total available capacity of 8,693,496 tons. At a current disposal rate of 203,689 tons, there would be approximately 43 years (8,693,496 tons ÷ 203,689 tons) of available industrial landfill capacity in Maryland.

Table C3 – Industrial Landfill Capacity

Landfill Facility Name	Permitted Capacity (CY)	Landfilled to Date (CY)	Landfilled to Date (Tons)	Remaining Capacity (CY)	Remaining Capacity (Tons)	Year Reach Capacity	Landfilled in 2016 (CY)	Landfilled in 2016 (Tons)	Used in 2016 ^
W.R. Grace and Co. – Davison Chemical Division	495,000	181,590	214,486	313,410	280,514	2029	18,936	20,789	3.83%
Eastalco Aluminum Company	380,000	152,365	184,142	227,635	300,008	2017	21,305	17,161	5.61%
Essroc Cement Corporation	273,000	0	0	273,000	273,000	N/A	0	0	0.00%
Hawkins Point Plant	3,228,044	2,288,727	3,661,736	939,317	1,503,134	2077	192	240	0.01%
Fort Armistead Road – Lot 15	6,300,000	539,237	593,160	5,760,763	6,336,840	2053	150,455	165,499	2.39%
TOTALS	**10,676,044**	**3,161,919**	**4,653,524**	**7,514,125**	**8,693,496**		**190,888**	**203,689**	**1.79%**

Objective: Estimate an increased density of waste + weekly cover.

Given: 4.8 days/lift ~~2.8~~ (days/lift)/ac ⟹ approx 1 acre ~~2~~ ac in one week w/ 1 lift of waste

Calculation:

Waste Amount: (1 acre ~~2~~ ac)(43,560 ft²/ac)(8 ft) = 348,480 cf ~~696,960~~ cF

$$\frac{(348{,}480\text{ cf } \cancel{696{,}960}\text{ cF})(44.0\text{ lb/cf})}{2000\text{ lb/T}} = 7{,}667\text{ Tons } \cancel{15{,}333}\text{ T} ✓$$

Weekly Cover Amount: d = 0.5', assume 75 pcf

$$\frac{(1\text{ acre } \cancel{2\text{ ac}})(43{,}560\text{ sf/ac})(0.5\text{ ft})(75\text{ lb/cf})}{2000\text{ lb/T}} = 817\text{ Tons } \cancel{1{,}633}\text{ T} ✓$$

Total = 8,484 Tons ~~16,966~~ T ✓

Combined Waste + Cover Density:

$$\frac{(8{,}484\text{ Tons } \cancel{16{,}966\text{ T}})(2000\text{ lb/T})}{(1\text{ acre } \cancel{2\text{ ac}})(43{,}560\text{ sf/ac})(8\text{ ft})} = 48.7\text{ pcf } \cancel{48.7}\text{ pcf}$$

* Use for calcs using vertical loads.

SHEET 1 OF 1. PROJECT NO. 2018-3084 PROJECT NAME Ches. Terr.
BY JCA DATE 7/4/20 DESCRIPTION Waste + Cover Density
CHK. BY JEJ DATE 7/4/20 Revised by PGS 08-26-2021

SECTION 6

SITE ENVIRONMENTAL CONDITIONS

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LIST OF ATTACHMENTS

6.0 SITE ENVIRONMENTAL CONDITIONS

6.1 Wetlands

Wetland areas shown on Drawing 2 were provided by McCarthy & Associates. The following summary regarding the status of the Wetlands Permit for the site is provided by Mr. Milton L. McCarthy.

"The wetland areas at Chesapeake Terrace are shown on (Drawing 2) of the Chesapeake Terrace Rubble Landfill Site Plan. The wetland boundaries have been most recently verified in the field by a representative of the Baltimore District of the Corps of Engineers on May 1, 2008. The Corps issued a permit for Chesapeake Terrace in 1991 CENAB-OP-RW (Chesapeake Terrace) 91-1204-3. The Corps of Engineers reissued the non-tidal wetlands permit on May 23, 2008 (see Appendix A). Maryland Department of the Environment Water Management Administration, Non-tidal Wetland and Waterway Division reissued the water quality certification for Chesapeake Terrace on December 13, 2007. This authorization is valid until December 31, 2010."

This authorization was extended by the United States Army Corps of Engineers until December 31, 2023 in a letter dated January 3, 2019. The previous submissions and correspondence with the USACE to obtain and extend the Wetlands Permit was included in Appendix M of the Phase II Permit Application and is not repeated here for brevity.

6.2 100-Year Flood Plain

6.2.1 Historical Flood Plain Analysis

Mr. J.A. Chisholm, P.E. performed a detailed evaluation of the 100-year flood plain evaluation. His evaluation is described in a letter to the Applicant dated October 14, 2003 (see Appendix B of the Phase II Permit Application). His evaluation is summarized below:

Mr. Chisholm noted that the site is adjacent to the Little Patuxent River approximately 30,000 feet (approximately 5.7 miles) upstream from the confluence of the Little Patuxent River with the Patuxent River. The 100-year flood plain limit shown upon the exhibits submitted to the MDE with the March 1990 Phase II Report was derived from the FEMA (Federal Emergency Management Agency) Anne Arundel County FIRM Panels 24 and 25 dated May 2, 1983. These panels showed the Little Patuxent River adjacent to the Chesapeake Terrace site. The footprint of the landfill is located above elevation 80, approximately 5 feet above the influence of the 100-year floodplain. As a result there is no encroachment into the floodplain that reduces hydraulic capacity or storage volume of the floodplain.

It was concluded that the proposed elevations for Chesapeake Terrace Rubble Landfill operations are located above the influence of any 100-year FEMA flood plain limits within the adjacent Little Patuxent River.

6.2.2 Updated FEMA Maps

In 2012, FEMA updated the National Flood Insurance Program, Flood Insurance Rate Maps (FIRM) for Anne Arundel County, as a result of increase in frequency and severity of recent storm events. Map number 24003C0136E shows the extent of the site and the flood boundaries near the site. Attachment 3B includes excerpts of this map, amended to include the site boundary for the Chesapeake Terrace Rubble Landfill.

AGC Montrose reviewed this map to discern whether it merits adjustment to the historical analysis performed by Mr. Chisholm, which also served as the basis for other permitting in Maryland. Zone AE, where base flood elevations were determined, is located along Patuxent Road and Little Patuxent River beyond it. The flood elevation in the vicinity of the site is designated between 72 and 73 ft msl, downgradient of location of FEMA cross-section Section I shown on the map.

The 2012 FEMA flood plain was inserted into Drawing 2. In reviewing the flood plain line presented on FEMA Map number 24003C0136E, it did not align with the actual topography of the site, where base flood elevations were determined on the FEMA FIRM map. Inconsistencies between FEMA maps and detailed site topographic information are commonly encountered because the FEMA maps do not have access to detailed site topographic information when they are prepared. To make the flood plain boundary be consistent with the actual site topography, we adjusted the floodplain line representing the water surface for the 100-year flood event calculated in the FEMA mapping to follow the contours from the detailed site topography. The flood plain taken directly from the 2012 FEMA Map is shown as the red-line on Drawing 2, while the flood plain line adjusted to match the detailed site topography is shown in the blue line. The 2012 FEMA floodplain boundary, as adjusted for site specific topography, was repeated on many of the other plan drawings included with the Phase III Permit Application.

While the base flood elevations determined in the 2012 FEMA FIRM Map are higher than those identified in Mr. Chisholm’s study, it does not affect the conclusion of his study, that the landfill is being developed at elevations above 80 ft msl in the existing conditions. In the vicinity of Patuxent Road, the proposed elevations of the landfill perimeter access road range from 80 ft msl (in the eastern limits) to 100 ft msl (near the Amtrak rail lines). Drawings 10 and 11 provide the proposed landfill perimeter road elevations, relative to the flood plain and cell floor subgrade grading.

6.3 Screening

Mr. J. A. Chisholm, P.E. prepared the natural screening/buffer provisions for the landfill. The screening/buffer concept is as follows:

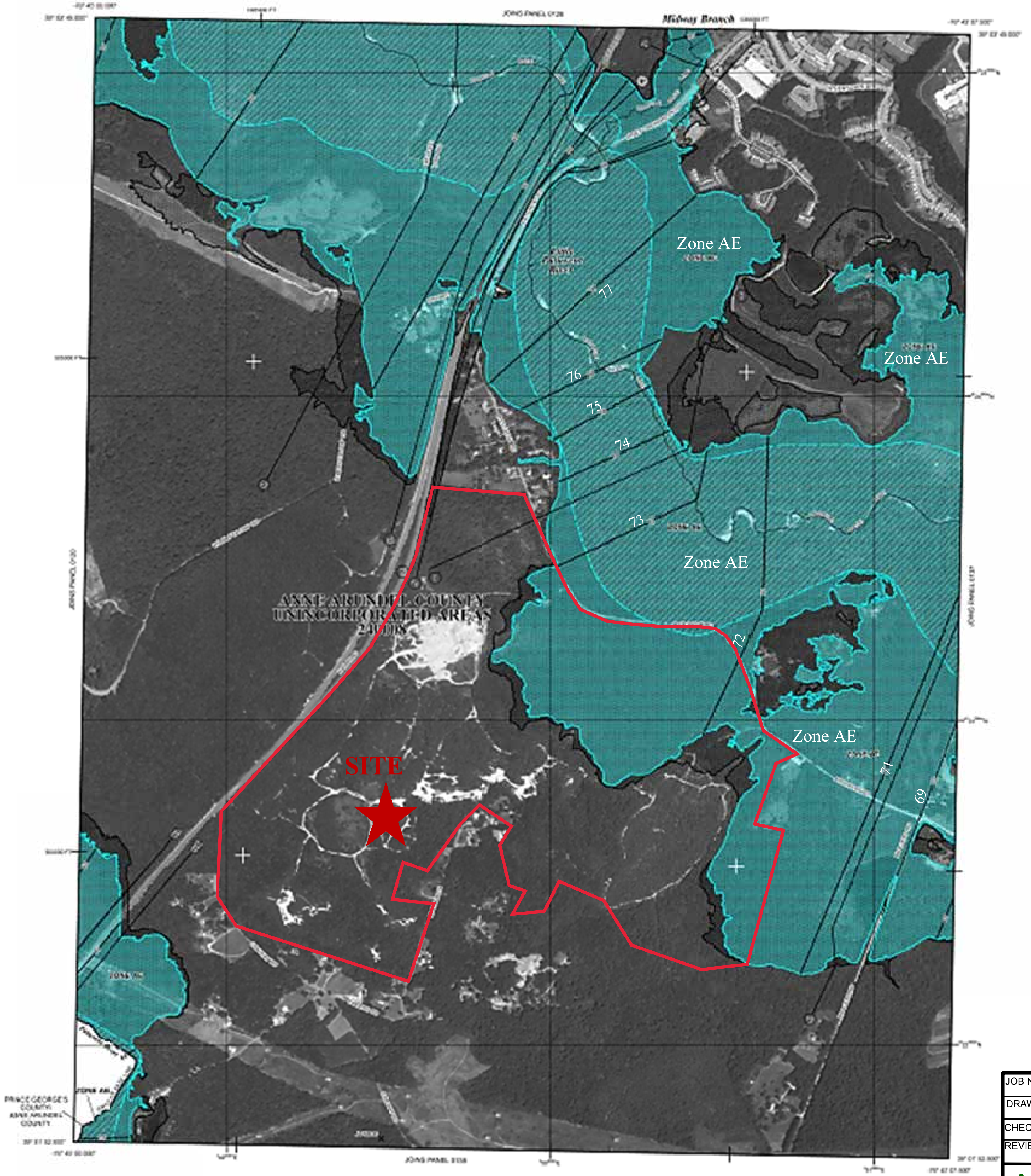
> "The existing site perimeter is generally heavily wooded. A 100 feet buffer (min.) is proposed by retaining existing woodlands. There are several areas of severe erosion that encroach upon the proposed buffers. These areas are located along the southern boundary. It is proposed to fill these areas and replant with minimum 6 feet to 8 feet white pines, 15 feet on center, with rows 15 feet apart to re-establish a minimum 100 feet vegetated buffer. The existing understory within the 100-foot buffer will be enhanced with supplemental plantings if necessary."

6.4 Residential Well Monitoring

The purpose of residential well monitoring is to determine whether operations at the landfill will have an unreasonable impact on off-site residential wells through lowering of the perched water table. The Landfill will provide mitigation measures at its expense if unreasonable impacts are determined. The residential well monitoring plan is provided in Section 16.0 Attachment 16C, "Residential Well Water Level Monitoring Program."

ATTACHMENT 6A

Excerpt from 2021 FEMA FIRM Flood Plain Map



LEGEND

▇	SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also knowa as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
▨	FLOODWAY AREAS IN ZONE AE

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0136E

FIRM
FLOOD INSURANCE RATE MAP

ANNE ARUNDEL COUNTY, MARYLAND
AND INCORPORATED AREAS

PANEL 136 OF 395

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ANNE ARUNDEL COUNTY	240008	0136	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
24003C0136E

EFFECTIVE DATE
OCTOBER 16, 2012

Federal Emergency Management Agency

JOB No.:	2018-3854	SCALE.:	Not to Scale
DRAWN BY.:	VEF	DATE.:	4/29/2019
CHECKED BY.:	VEF	FILE:	Pllate 3
REVIEW BY.:	VEF		

Excerpts - 100-YEAR FLOODPLAIN (FEMA, 2012)

Advanced GeoServices

Chesapeake Terrace Rubble Landfill

Attachment 6A

SECTION 7

SEQUENCE, SCHEDULE AND CONTRACT DOCUMENTS FOR LANDFILL CONSTRUCTION

TABLE OF CONTENTS

7.0 SEQUENCE, SCHEDULE AND CONTRACT DOCUMENTS FOR LANDFILL CONSTRUCTION

7.1 Overview

7.1.1 Landfill Site Entrances

Three site entrances (i.e., East, North, and South entrances) are shown on the Drawings. Construction of only one site entrance (comprised of access road, scale house, truck scales, maintenance building, wheel wash, and cleanout) is required for rubble landfill operation. Site Entrance Description is provided in Section 3.4.

As indicated in Section 3.6, the East Entrance is required by the Anne Arundel County Special Exception Permit. Consistent with the redundancies included in landfill design, there will be an "emergency exit" road, one lane wide at the location of the Optional North Entrance, to allow exit by all at the landfill, if the entrance is blocked by some unusual circumstance (e.g., fallen tree, downed power line, etc.).

If the Optional North Entrance is constructed instead of the East Entrance, another location for this "emergency exit" will be selected in consultation with appropriate governmental agencies.

7.1.2 Landfill Cell Construction

The site for the proposed facility is comprised of areas previously mined for sand and gravel. Primary landfill areas are referenced as East Section (Cells 11-16) and West Section (Cells 1-4, 5A-5F, and 6-10) on Drawings. Each cell is lined and sloped in accordance with Code of Maryland (COMAR) Regulations, as necessary to create a sump for collection of leachate (e.g., surface water percolation through rubble waste placed in the cell).

Two leachate storage facilities will be constructed to provide temporary storage of leachate from the landfill cells. In each leachate storage facility, two 500,000-gallon tanks will be installed within an area surrounded by a secondary containment wall. There are fifteen cells/subcells (each with submersible pumps in a leachate collection sump) in the West Section and six cells (each with submersible pumps in a leachate collection sump) in the East Section.

Leachate force main #3 conveys leachate from Cells 2-4 in the West Section and all cells in the East Section will be pumped to force main trunk lines connected to Leachate Storage Facility No. 1. Leachate force mains #1 and #2 convey leachate from Cells 1, 5A-5F, and 6-10 in the West Section are connected to Leachate Storage Facility No. 2.

Five basins are designated for construction as part of this project (Basin Nos 1 through 4 and WQ_v Basin). Three (3) basins (Nos. 1 through 3) will serve as Sediment Control and Stormwater Management Structures for runoff from the proposed waste disposal areas during construction; prior to waste placement within a cell or subcell; and after placement of the Final Cover layer. (Stormwater falling within or running into a cell during active filling operation is regulated as leachate and cannot be discharged to the basins, or any other stormwater management feature.) Basin No. 1 manages runoff from the West Section; Basin No. 2 manages runoff from a small segment of the East Section, and upgradient off-site drainage areas and upgradient on-site drainage areas outside the proposed perimeter access road and proposed limits of disturbance. Basin No. 3 manages runoff from the majority of the East Section construction. After the landfill is closed, these three basins will be converted for long-term stormwater management.

Basin No. 4 manages runoff from the proposed East Entrance and upgradient off-site drainage areas and upgradient on-site drainage areas outside the proposed perimeter access road and proposed limits of disturbance. Basin No. 4 will provide Sediment Control and Stormwater Management during construction of the East Entrance and adjacent support area. After completion of East Entrance construction and stabilization, Basin No. 4 will remain to provide stormwater management control. The WQ_v Basin receives runoff from approximately 800 feet of the East access road. The WQ_v Basin will provide Sediment Control and Stormwater Management during construction of the entrance road and operating life of the landfill.

Silt fence, check dams, erosion control mat, temporary vegetation, and other proven temporary and permanent erosion control measures ensure that sediment from disturbed areas outside basin drainage areas is contained on-site. A range of measures available to the site operations personnel are outlined in the Maryland Standards and Specifications for Soil Erosion and Sediment Control (2011, or latest edition)

.

Prior to beginning landfill construction in any given area, sediment basins and perimeter controls required for that area shall be installed as shown on plans and indicated in Section 7.2, "Sequence of Construction for Landfill Cells." As specified in the sequence, each basin shall be completely constructed (e.g., topsoil shall be cleared and stripped, cut-off trench shall be installed, spillway, excavation, and embankment construction shall be performed) before other construction activities within the associated contributing drainage area can begin. Prior to beginning basin construction, all required construction materials for the basin must be on-site. Stormwater, precipitation and groundwater entering the basins during construction will be dewatered per details on plans.

Composite view of all landfill cells at cell bottom of subgrade elevations is provided on Drawings 6 and 7. Grades on cell subgrade plans indicate that each cell will be graded to its own sump, in which a submersible pump will be installed in a sideslope riser pipe, as shown on Drawing 19. The embankment that runs perpendicular to the sump, coupled with completely constructed grades in the cell, assures positive drainage to the sump and sediment containment within a cell under construction. Storm water impounded in a cell under construction shall be pumped to an area where positive drainage to a sediment basin (e.g., perimeter channel) is provided.

Rubble waste may not be placed in any cell until the corresponding leachate storage facility and force main to the cell have been completely constructed and tested. Vehicular access to the storage tank for loading and transport of leachate must be provided and maintained. Upon completion of construction of the liner system in the cell, cell construction material testing (including leachate pump and leachate force main), and connection of the force main system to the storage tank, the construction Quality Assurance Consultant (QAC) will provide a report documenting the construction of the liner and leachate management systems to MDE for approval. Upon approval by MDE, landfilling activities in that cell may commence.

At all times during the waste placement operation in a cell, waste shall be placed in a manner that ensures collection of leachate in the cell sump area. Routine and final cover shall be placed in accordance with MDE Refuse Disposal Permit stipulations.

To summarize and clarify events that occur chronologically (on a cell-by-cell construction basis), Section 7.2, "Sequence of Construction for Landfill Cells", stipulates conditions under which the landfill will be constructed, from beginning to end of construction. See Drawings 64 through 81 for Intermediate Construction Stage Plans, which illustrate sequence of events to construct the landfill from beginning to end of construction.

Unless otherwise approved by MDE and Anne Arundel Soil Conservation District, Landfill Cell Sequence of Construction will be per Intermediate Stage Construction Drawings, referenced under Section 7.2.2. Cells will be constructed individually or in groups, per the chronological requirements under Section 7.2.5, "Landfill Construction Chronology". Variance from Cell Sequence of Construction is referenced under Section 7.3. Time frames for construction during the life of the landfill operation are given under Section 7.5, "Estimated Cell Construction and Waste Placement Schedule".

Rubble fill operation may proceed in any given completed cell at any time throughout the life of the facility, provided that: sediment controls for the disturbed area are in place and maintained; leachate is properly collected and disposed, and all other conditions of the MDE Refuse Disposal Permit are met.

7.2 Sequence of Construction for Landfill Cells

Unless "Variance from Sequence of Construction for Landfill Cells" is obtained, per Section 7.3, the landfill will be constructed in accordance with criteria provided hereunder. "Surface Runoff/Sediment Control" shall be provided per Section 7.2.1. Section 7.2.2, "Description of Intermediate Construction Stage Plans" and Section 7.2.3, "Assumptions for Development of Landfill Sequence of Construction" describe site conditions and assumptions under which the Landfill Sequence of Construction was determined. Section 7.2.4, "Intermediate Construction Stage Plan Depiction" indicates construction requirements consistent with depiction on each Intermediate Construction Stage Plan. Section 7.2.5, "Landfill Construction Chronology", lists the Sequence of Construction specified on Drawings.

7.2.1 Surface Runoff/Sediment Control

As referenced under the Sequence of Construction Overview above, all cells will be constructed in a manner that will create a sump, and lined with material specified on Drawings. Clean surface runoff from adjacent undisturbed areas will be diverted around the cell construction area, to the extent practicable. During construction, clean surface runoff impounded in cell sumps will be pumped to a constructed permanent perimeter channel or temporary channel, as required to ensure that water from cells under construction will drain through Basin No. 1, 2 or 3.

Construction of access roads and perimeter ditches adjacent to cell areas is referenced under the Sequence of Construction on each Intermediate Stage Construction drawing. In cell construction areas where the perimeter ditch is to be created by fill, the 10-foot minimum top width perimeter berm at the top of the landfill embankment sideslope shall be part of the construction.

As practicable, to reduce sediment-laden surface runoff to sediment basins throughout the life of the construction operation, the landfill operator shall attempt to minimize un-vegetated disturbed areas that drain directly to a Sediment Basin (via existing drainage swales, constructed perimeter ditches, or temporary measures). Permanent or temporary vegetative stabilization, as applicable, shall be applied on disturbed areas, per MDE Refuse Disposal Permit stipulation, before other construction proceeds.

7.2.2 Description of Intermediate Construction Stage Plans

Intermediate Construction Stage Plans (Drawings 64 through 81) depict construction of the landfill from beginning of construction throughout construction of all landfill cells.

The following site conditions were considered in determining Sequence of Construction for Landfill Cells, illustrated on Intermediate Construction Stage Plans.

1. The East Section is constructed first as there is an excess of excavated material that can be used for road and Basin construction. Excess material can be used for intermediate cover, routine cover, or construction of perimeter roads and berms in the west section, as excess material becomes available and is appropriate for the proposed use, based on the nature of the material.

2. While the proposed grading plans provide a net cut situation in both the East and West Sections during cell construction and landfill operation, additional material may be needed for closure cap construction. The owner/operator may choose to consistently import material from off-site throughout the landfill operation to take advantage of readily available material in the area. This material may be staged on-site until used.

3. The primary means of sediment control for construction of the site is by perimeter channel drainage to sediment basins. Natural and constructed drainage swales from the former sand and gravel mining areas convey surface runoff through the site in a predominantly northern direction. Once sediment controls are in-place, as cell construction proceeds, clean surface runoff drainage will be diverted around construction areas, to the existing swales. Until precluded by cell construction, existing swales will convey clean surface runoff to perimeter channels and sediment basins, as shown on Intermediate Construction Stage Plans.

4. In order to reduce leachate generation over the life of the operations and after closure construction, it is expected that the operator will advanced

construction of the closure cap when areas typically between 5 and 10 acres have achieved maximum filling grades. These areas may span more than one cell and may close portions of multiple cells, based on maximum filling grades, not cell boundaries.

7.2.3 Assumptions for Development of Landfill Sequence of Construction

Based on the above site conditions, the following assumptions were used to develop the Landfill Sequence of Construction, depicted on Intermediate Construction Stage Plans on Permit Drawings.

1. Landfill Cells 2 through 4 and 11 through 16, whereby leachate is pumped to Leachate Storage Facility No. 1, will be constructed prior to Cells 1, 5A-5F, and 6-10. This allows construction of the Leachate Storage Facility No. 1 for the management of leachate for the first approximate 5 years of operation. Depending upon the waste volume received, this timeline could be longer or shorter. Construction of Leachate Storage Facility No. 2 should commence no later than the beginning of landfilling activities in Cells 3 and 4.

2. With respect to landfill operation, construction of Cells 11-16 are the first to be constructed and operated in light of their proximity to the East Entrance and Scalehouse. Further, construction of Landfill Cells 2 through 4 and Cells 11 through 16, prior to construction of the remaining cells, is also the most desirable sequence of construction for the landfill, due to close proximity of these cell construction to sediment basins.

3. Three site entrances to the landfill are depicted on Drawing 3. MDE requires only one entrance. South entrance is considered the least desirable of the three site entrances, because it is remote from landfill cells that should be constructed and filled with rubble waste initially.

   North and East Entrances, in close proximity to cells that should be constructed initially, are the most desirable Site Entrance Options. Shortest distance from an existing County Road to the landfill perimeter access road is via the North Entrance. Assumption used to develop the Sequence of Construction indicated on Intermediate Construction Stage Plans (Drawings 64 through 81) is that rubble waste haul to the site will be via Conway Road to the East Entrance. Site access via the East Entrance is a conservative assumption, in that construction of a long access road across off-site property is required.

4. Variance from the Sequence of Construction on Permit Drawings must be approved by AASCD and MDE, per Section 7.3. Contract Documents for Intermediate Stage Construction must be prepared and approved by MDE, per Section 7.6.

7.2.4 Intermediate Construction Stage Plan Depiction

Sequence of Construction for each Intermediate Construction Stage is provided on Drawings 64 through 81. The following list identifies construction requirements, methodology associated with depiction of features on Intermediate Construction Stage Plans, As-Built Survey and Quality Assurance requirements.

1. Perimeter Access Roads: Perimeter Access Roads initially used for construction equipment access shall have a surface sufficient for such use. Permanent perimeter road surface for waste haulers shall be per the Section on Drawing 8. Temporary access roads used for waste haulers in cell areas and on rubble waste shall have an all weather surface suitable for such use.

2. Perimeter Channels: Perimeter channels shall include lining per the tabulation on Drawing 42. Temporary berms, riprap channels and ditches adjacent to temporary roads shall be sufficient to convey surface runoff around cell construction and waste placement areas as shown.

3. Sediment Basins: Initial construction stage includes construction of sediment basins and perimeter channels construction necessary to provide surface runoff to basins, consistent with basin design criteria. Following this construction, stockpiles shall be placed within the limit of disturbance and drainage area to a sediment basin, throughout the life of landfill construction and operation.

4. Proposed Contours: For clarity, proposed contours required to implement construction of each Intermediate Construction Stage are referenced as "Proposed Contours" on Intermediate Construction Stage Plan Legends. Temporary access roads and channels for cell construction will be graded per Intermediate Construction Stage Plans and Details, per conditions specified under Section 7.2, "Sequence of Construction for Landfill Cells", Section 7.3, "Variance From Sequence of Construction for Landfill Cells" and Section 7.6, "Preparation of Contract Documents for Intermediate Stage Construction".

5. Constructed contours adjacent to temporary roads and ditches represent grading requirements for constructing cells and access on existing ground prior to landfill construction. Per Item 6 below, stockpiles and borrow areas may exist in some locations shown as existing ground on Intermediate Construction Stage Plans.

6. Stockpile Borrow Areas: all areas within the boundary of the landfill may be used for stockpile and borrow sources for landfill operation throughout the life of the facility. Stockpiles and borrow sources may be within areas adjacent to temporary access roads and ditches for cell construction (see Item 5 above) at time of construction. Sufficient space for cell access and surface runoff diversion around cell construction and waste placement shall be provided throughout the life of the facility.

7. Inter-Cell Access: Inter-cell access for cell construction or waste placement shall be via temporary access roads or over covered rubble waste in active cells, as shown on Drawing 15.

8. As-Built Survey: Throughout the life of landfill construction and operation, field run and aerial topographic as-built survey for each construction phase shall be performed in accordance with Contract Documents, to be prepared per Section 7.6, "Preparation of Contract Documents for Intermediate Stage Construction".

9. Quality Assurance: All cell construction material (including subbase and leachate collection system) shall be installed and tested in accordance with Contract Documents. Prior to beginning waste placement in any cell, approval from MDE Inspector shall be obtained.

7.2.5 Landfill Construction Chronology

Prior to beginning any waste placement and at least 12 months before the commencement of waste disposal operations, permanent groundwater monitoring wells within the respective area (West Section and East Section) shall be installed, as described in the "Groundwater Monitoring Plan" in the Phase III Report, Section 16.

Per criteria and assumptions under Sections 7.2.1, 7.2.2, 7.2.3, and 7.2.4 above, landfill construction chronology depicted on Intermediate Stage Construction Drawings 64 through 81 is as follows:

1. East Section Initial Construction (Basin Nos. 2, 3 and 4; Perimeter Channels 1, 6, 7, 9A and 10 and associated culverts; East Section perimeter road; and Leachate Storage Facility No. 1);

2. Cell 11, associated perimeter berm, and portions of Leachate Force Mains #4 and #5;

3. Cell Separation Berm for Cells 12 through 16;

4. Cell 16, associated perimeter berm and remainder of Leachate Force Main #5;

5. Cells 12 through 15, respectively, and the remainder of the East Section perimeter berm, perimeter road, perimeter channels, and remainder of Leachate Force Main # 4;

6. West Section Initial Construction (Basin No. 1; Leachate Force Main #3, perimeter road, northern portions of perimeter channels 2, 3, 4, and 5, and associated culverts);

7. Cells 2, 3 and 4, respectively;

8. Cells 1 5E and 5F (including Leachate Storage Facility No. 2 and Leachate Force Mains #1 and #2);

9. Cells 10 and 5D; and,

10. Cells 9 & 5C, 8, 5A & 5B, 6, and 7, respectively.

7.3 Variance from Sequence of Construction for Landfill Cells

As referenced under Section 7.2.3, Sequence of Construction is based on site access via the East Entrance. If the North Entrance is constructed in lieu of the East Entrance, the Sequence of Construction will be identical, except that the perimeter access road between the North and East Entrances and portions of Perimeter Channels No. 8 and 9 will not be constructed, until necessary for construction of Cells 12 through 15. If the North Entrance is constructed in lieu of the East Entrance, and Sequence of Construction for Landfill Cells is in accordance with Drawings, Variance from the Sequence of Construction herein is not required. If the South Entrance is the only site access that is ultimately constructed, the Sequence of Construction will be revised and must be approved by Anne Arundel Soil Conservation district (AASCD) and MDE.

7.4 Sequence of Rubble Waste Placement Operation

Sequence of rubble waste placement is as follows:

1. For each Intermediate Stage of Construction, prepare the cell subbase in accordance with Contract Documents (see Section 7.6) and requirements of the Refuse Disposal Permit.

2. Construct the rubble landfill per Intermediate Construction Stage Drawings 64 through 81. Place waste in individual cells in East and West Sections as shown. As rubble waste placement progresses, provide routine and intermediate cover per Refuse Disposal Permit requirements.

3. When rubble waste is elevated above the Landfill Perimeter Berm, provide cover and vegetation in a manner that promotes surface runoff from soil cover over the rubble, across the perimeter berm to a perimeter channels.

4. Continue the rubble waste placement operation until maximum waste grades are achieved. Estimated life expectancy of the rubble waste placement operation is 12 years. Final grades shown on Drawings 32 and 33 represent the top of the 24-inch thick Final Cover layer. Top of waste grades are presented on Drawings 30 and 31. Top of Closure Cap grades are presented on Drawings 36 and 37. Final Cover Layer and Closure Cap shall be installed per MDE regulations. Final Closure Cap side slopes shall be no steeper than 4H:1V, with slope benches and articulated concrete mat (aka cable-concrete mat) downchutes installed per Drawings and Details.

5. When Closure Cap has been constructed and vegetated per the Drawings, sediment basins shall be converted to permanent stormwater management structures.

7.5 Estimated Cell Construction and Waste Placement Schedule

At least 12 months prior to waste placement within a particular landfill section (West Section or East Section), the permanent groundwater monitoring wells required for that Section shall be installed, as described in the "Groundwater Monitoring Plan" in the Phase III Report, Section 16.

In accordance with all conditions specified, the landfill shall be constructed. Intermediate Construction Stage Plans (Drawings 64 through 81) depict construction of the landfill from beginning of construction throughout construction of all landfill cells. Sequence of Construction is provided on each Intermediate Construction Stage Plan. Estimated time frame for cell construction and waste placement is provided hereunder.

Prior to beginning any other on-site construction, Intermediate Construction Initial Stage, per plans on Drawing 64, shall proceed. Under initial construction, East Entrance, Sediment Basins 2 and 3, Basin 4, East Section Perimeter Access Road, Drainage Channels and Leachate Storage Facility No. 1 will be constructed. Areas outside the limit of disturbance for initial construction may be used to stockpile excavated material from the construction operation, as approved by the AASCD Sediment Control Inspector. Excluding access roads and Assumed East Entrance Infrastructure, all disturbed areas shall be stabilized with vegetation.

Based on the anticipated volume and density of rubble waste to be placed in the facility on a daily basis, during weekly operation, the estimated life expectancy of the landfill waste placement operation is 12 years.

7.5.1 Construction Requirements

The following construction requirements and assumptions were used to generate the "Sequence of Cell Construction and Waste Placement", under Section 7.5.2.

1. Duration of the landfill waste placement operation is 12 years. Initial construction of roads, Basins, and Leachate Storage Facility No. 1 require extensive time for cell construction that is excluded from the waste placement time frame.

2. Final closure of the facility (i.e., the construction activities associated with installation of Final Cover layer and Closure Cap on the final waste placement areas (Cells 6 and 7)) is not considered to be part of the 12 year operating life..

3. Construction of cell infrastructure (i.e., access roads, perimeter channels, drainage culverts, and leachate force mains) will occur as required to support ongoing landfill cell construction. Cell infrastructure construction

should be scheduled and completed as necessary to allow waste placement in any given cell, immediately following cell construction completion.

7.5.2 Sequence of Cell Construction and Waste Placement

Prior to beginning work for any Intermediate Stage of Construction (as shown on Drawings 64 through 81 and specified herein), Anne Arundel County Planning and Code Enforcement (PACE) Inspections and Permits (410-222-7780) shall be notified. All proposed stockpile areas (including temporary sediment control measures) shall be per AASCD Sediment Control Inspector's approval.

Based on individual cell air space (prorated per total landfill cell acreage) and Intermediate Construction Stage Plans on Drawings 64 through 81, the "Sequence of Cell Construction and Waste Placement" is as follows.

1. Complete Intermediate Construction Initial Stage (East Section), including East Entrance with all sediment control measures, Sediment Basin Nos. 2 and 3, Pond 4, and Leachate Storage Facility No. 1, with appurtenant road, channels, etc. See Drawings 64 for Intermediate Construction Initial Stage Sequence of Construction. Estimated Time Frame for Item 1 Completion is 2 years (not part of 12-year waste placement estimate).

2. Construction of all sediment basins shall comply with the following.

   - All materials for basin construction shall be on-site prior to commencement of work.
   - Prior to commencement of work, areas for clearing, stripping and stockpiling topsoil or any imported borrow, and any on-site borrow areas (including temporary sediment control measures, such as silt fence, etc.) shall be per approval of the AASCD Sediment Control Inspector.
   - Sediment basins will be constructed per approval by MDE and AASCD, as shown on Drawings. Construction of the cut-off trench, principal and emergency spillways, and all other aspects of dam construction, shall be inspected by a Professional Geotechnical Engineer or his authorized representative.
   - During the life of cell construction and waste placement, sediment basins will be constructed and dewatered per details on Drawing 62. Following application of permanent vegetative stabilization in contributing drainage areas, dewatering measures will be removed and basins will be converted to permanent stormwater management ponds, as specified on Drawings 53 and 54.

3. Construct East Section (approximately 30.6 acres air space) per Section 7.2.5. Complete placement of waste and Final Cover layer (i.e., 2 feet above rubble waste, which is 2 feet below closure cap). Closure Cap construction will typically be completed in 5 to 10 acre segments.

4. Construct West Section Cells 1 through 10 (approximately 83.8 acres air space) per Section 7.2.5. Construct Sediment Basin No. 1 prior to

construction of West Area perimeter access road and Cells 2, 3 and 4. Construct. Construct Leachate Storage Facility No. 2 prior to Cells 1 and 5E and 5F construction (see Drawing 73). Complete placement of waste and Final Cover in West Section. Closure Cap construction will typically be completed in 5 to 10 acre segments. Completion of remaining portions of Final Cover and Closure Cap after the end of waste placement is not considered part of 12-year waste placement estimate.

5. Phase construction of the closure cap is expected to occur in the East and West Sections as landfilling achieves maximum grades. Further, COMAR regulations require closure cap construction to be complete within 36 months of the placement of the final waste within the landfill.

6. Complete landfill Closure Cap as required and approved by MDE. With approval of AASCD Inspector, convert Basin Nos. 1, 2 and 3 to permanent stormwater management ponds, as specified on Drawings 53 and 54.

7.6 Preparation of Contract Documents for Intermediate Stage Construction

Prior to beginning construction for each Intermediate Construction Stage, Construction Drawings and Construction Specifications (i.e., Contract Documents) sealed by a Professional Engineer, registered in Maryland, shall be prepared and submitted to MDE for approval. Construction of the site's three sediment basins, temporary sediment traps, and other sediment control measures shall be as approved by MDE and AASCD, per Drawings.

Minimum requirements regarding content of Contract Documents are as follows:

1. All Construction Drawing plan views shall be prepared at minimum 1-inch = 50-foot scale.

2. Coordinate geometry shall be Anne Arundel County grid, per coordinates shown on the Drawings.

3. Site entrance road(s) and infrastructure (i.e., scale house, truck scales, maintenance building, wheel wash and cleanout) shall conform to the plans shown on Drawings 4, 5, 89 and 90, as appropriate. Minimum tractor-trailer turning radius shall be 55 feet. Minor adjustment to the layouts may be made as necessary, and additional dimensions shall be added as required to ensure proper construction, in conformance with tractor-trailer movement on truck scales and wheel wash, and operational equipment movement within and adjacent to the maintenance building.

4. Base line for construction of leachate storage facilities shall be centerline of all access roads that surround the areas, as shown on the Drawings. Each leachate storage facility includes a secondary containment berm, designed to provide 500,000 gallons containment capacity for leachate storage tank leaks, with 1-foot freeboard from liquid level to top of berm (see Drawings 28 and 29). Minor adjustment to leachate storage facility horizontal and vertical alignment (i.e., adjustments to accommodate tanker truck

movement and installation of storage tanks, secondary containment structures, etc. shall be made as necessary. Leachate storage facilities shall not be smaller than facilities depicted on the Drawings. There is ample room to increase the area of each facility in the immediate vicinity of those facilities.

5. Base line of construction for the landfill cells shall be the perimeter access road centerline, as shown on the Drawings. Precise curvilinear and vertical alignment for the road shall be computed based on proposed alignment and elevations shown. Any discrepancy between the road shown on landfill plans, and Sediment Basin Plans on Sheets 47 through 50, shall be governed by the landfill plans.

6. Perimeter access road centerline shall be used to develop road centerline profiles on construction drawings. Profiles shall be prepared at minimum 1-inch = 50-foot horizontal and 1-inch = 5-foot vertical scale. Minor adjustments to road horizontal and vertical alignment may be made as necessary. Perimeter access road shall be constructed per the base line for construction, centerline profiles, and the cross sections on the Drawings.

7. Horizontal location of landfill cell separation berms and leachate pumphouses shall be per depiction on the Drawings.

8. Landfill sideslopes and cell grades at top of prepared subgrade elevation shall be per depiction on the Drawings. Leachate collection system liner material and dimensional criteria shall be per Drawing Details for the Alternate Liner System.

9. Construction of landfill perimeter channels and drainage culverts, perimeter berm, leachate pumphouses, sideslope riser pipes, and leachate sumps shall be per dimensional criteria, as shown on Drawing Details. Baseline of construction (i.e., the perimeter access road centerline) shall be the reference for all dimensions shown.

10. Construction of leachate force main shall be per the Drawing Plans and Details. Construction Drawings shall include profiles of the force main, at minimum l-inch = 50-foot horizontal and 1-inch = 5-foot vertical scale.

11. Storm drain pipe headwalls shall be per "Anne Arundel County Standard Details for Construction". To accommodate headwall construction, perimeter channels will be widened as necessary. Details for construction of pumphouses, maintenance building, and other appurtenances (i.e., truck scales, scale house, storage tank ring walls, etc.) shall be provided on Construction Drawings.

12. Construction Specifications (including but not limited to Construction Specifications in Section 14.0) that specify materials and installation requirements (including quality assurance/quality control for leachate collection system installation and testing) for each construction item

associated with construction of landfill cells and all appurtenances shall accompany Construction Drawings for each Intermediate Stage of Construction. All items associated with landfill operation (i.e., pumps, valves, electrical wiring, monitoring devices, etc.) shall be included in Construction Specifications.

13. General Specifications (including but not limited to the following) shall be provided.

    - 01050 Field Engineering/Surveying
    - 01200 Project Meetings
    - 01300 Submittals
    - 01400 Quality Assurance
    - 01410 Laboratory Testing Services
    - 01500 Construction Facilities
    - 01530 Job Site Security
    - 01540 Dust Control
    - 01560 Site Access & Traffic Plan
    - 01564 Project Record Documents
    - 01666 Cleaning and Testing of Piping

SECTION 8

SOILS DESCRIPTION

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LIST OF ATTACHMENTS

8.0 SOILS DESCRIPTION

8.1 Existing Soil Types

Description and evaluation of subsurface information is presented in the site's Phase II Permit Application, prepared by AGC Montrose in July 2020, through the incorporation of new site-specific data and re-interpretation of a previous version of the document entitled "Phase 2 Addendum for Chesapeake Terrace Rubble Landfill," dated December 5, 2003, prepared by Mark Schultz Associates.

8.2 Geomorphology

The Coastal Plain deposits are unconsolidated to semi-consolidated sedimentary deposits. The Coastal Plain extends east to the Atlantic Ocean and west to the Piedmont Physiographic Province. Coastal Plain deposits are comprised of materials eroded and transported from upstream sources and typically deposited by water below sea level and along rivers. The size and gradation of the sediments comprising coastal plain deposits can range from clays to coarse gravel to boulders, depending on the energy associated with the depositional environment. The uniformity of the deposits can range from vertically and laterally significant homogeneous deposits to highly variable localized heterogeneous deposits.

The separation between the Coastal Plain and the Piedmont Physiographic Provinces (“Fall Line”) is mapped as being within Howard County approximately 10 miles northwest of the site. Coastal plain deposits in the west central portion of Anne Arundel County thicken from northwest to southeast beginning at nearly zero feet thick at the border with Howard County to approximately 1,800 feet thick in the vicinity of Annapolis.

8.3 Regional Geology and Hydrogeology

The Geologic Map of Anne Arundel County (Glaser, 1976) identifies the vicinity of the site as being predominantly Lower Cretaceous sediments of the Potomac Group, with non-conforming contacts of Quaternary Terrace and Alluvial deposits. Based on MGS Investigation 46, at the site crystalline bedrock is >800 feet below ground surface (bgs). In this region the Potomac Group soils are reported to be over-consolidated as a result of the weight of a substantial thickness of overlying soils that have since been eroded away. As a result of that over-consolidation, Potomac Group soils are generally denser/stiffer-harder than the quaternary deposits.

Based on results of the subsurface investigations, site reconnaissance and a review of geologic information, no Holocene faults have been identified on or within 200 feet of the proposed landfill.

8.3.1 Potomac Group

Within Anne Arundel County the Potomac Group is described as being very complex. Because formations of the group were deposited under fluvial and lacustrine conditions sand, silt, and clay layers are commonly limited in lateral extent. Consequently, a boring log taken at a given point may very well not be applicable to sediments at the same stratigraphic level a few hundred feet in either direction (MGS, 1969). Despite that potential for variability, as a hydrogeologic resource the Potomac Group is commonly discussed in terms of three distinct formations. These are the Patuxent Formation, Arundel Formation and Patapsco Formation, as described below:

- The Patuxent Formation represents the bottom (oldest) of the Potomac Group and has a non-conforming contact with the saprolitic surface of the underlying crystalline bedrock. Lithologically the Patuxent is comprised of white or light gray to orange-brown, moderately sorted sands and subrounded quartz gravels; silts and clays subordinate, predominantly pale gray. The Patuxent Formation yields relatively large quantities of water (MGS Administrative Report 09-02-04 (A. Staley, et. al., 2009)). Based on figures contained in Administrative Report 09-02-04, the upper surface of the Patuxent Aquifer in the vicinity of the proposed Chesapeake Terrace Landfill is on the order of elevation -450 ft amsl.

- The Arundel Formation (referred to as the Arundel Clay Formation in some publications) directly overlies the Patuxent aquifer, and functions as a hydraulic separating layer between the Patuxent and Patapsco Aquifers. MGS Administrative Report 09-02-04 (A. Staley, et. al., 2009) estimates the top of the Arundel Formation in the vicinity of the project site to be on the order of elevation -300 ft amsl, with a typical thickness on the order of 200 feet. The Arundel Formation outcrops approximately 5 miles northeast of the project site.

- The Patapsco Formation is the uppermost member of the Potomac Group, and is typically discussed in terms of the Lower Patapsco Aquifer and the Upper Patapsco Aquifer separated by a confining layer. Descriptions of each follow:

    - The Lower Patapsco Aquifer, overlies the Arundel Formation. The Lower Patapsco Aquifer is one of the primary sources of water in the Glen Burnie and Severndale areas. MGS Report of Investigation No. 46 maps (F. Mack and G. Achmad, 1986) the outcrop of the top of the Lower Patapsco Aquifer at approximately 2 miles northeast of the site. The same document shows the top of the Lower Patapsco Aquifer in the vicinity of the site on the order of elevation -50 ft. amsl.
    - A low permeability layer separates the Lower Patapsco Aquifer from the Upper Patapsco Aquifer. Where this layer is described as a “clay” (or predominantly clay) in the boring logs we have designated this layer as the Middle Confining Unit (MCU). Beginning where intervals below the MCU are described as including intervals that are predominantly “silt” or “sand” we designated all deeper deposits (even if they transitioned back to clay or predominantly clay) Based on a top of the Upper Patapsco Aquifer (see below) at elevation -50 ft. amsl, as a general expectation the top of the MCU should be on the order of elevation +30 ft. amsl.
    - The Upper Patapsco Aquifer (UPA) represents the uppermost permeable water bearing zone within the Potomac Group. The UPA is comprised of laterally and vertically significant deposits of permeable materials (primarily sand) that collectively serve as a source of potable water in the County. The Upper Patapsco Aquifer is described as one of the best water bearing formations in Anne Arundel County, but it is much more limited in areal extent than the Lower Patapsco and Patuxent Aquifers (MGS Report of Investigation No. 46). The

MGS Report of Investigation No. 46 shows the outcrop for the Upper Patapsco Aquifer on and immediately northwest of the project site. With the unit gone approximately ½ mile west of the site. Administrative Report 09-02-04 (A. Staley, et. al., 2009) shows the surface of the Upper Patapsco Aquifer on the order of elevation +120 ft. amsl. The Upper Patapsco Aquifer can be under confined conditions where an Upper Confining Layer (UCL) is still present and separating it from the overlying Magothy Formation. Based on information presented in Administrative Report 09-02-04 (A. Staley, et. al., 2009), the top of the confining layer in the vicinity of the site is encountered at or around elevation +150 ft. msl.

8.3.2 Magothy Formation

The Magothy Formation (aka Magothy Aquifer) overlies the Potomac Group, it is reported to be hydraulically connected in varying degrees from place to place with the underlying Patapsco aquifer. It consists of 40 to 60 ft. of loose, white, cross-bedded, "sugary", lignitic sands and dark gray, laminated silty clays; white to orange-brown, iron-stained, subrounded quartzose gravels (MGS Report of Investigation No. 46). The same report shows the outcrop of the Magothy Aquifer immediately southeast of the project site. The Geologic Map of Anne Arundel County (J. Glaser, 1976) shows the Magothy Formation being present in the south east area of the site, which coincides with the highest topographic surface.

8.3.3 Quarternary Deposits

Investigation activities identified quaternary terrace and alluvial deposits throughout Area A. Quaternary deposits were not present within Area B. This is consistent with the Geologic Map of Anne Arundel County (Glaser, 1976), that identifies these geologically more recent deposits along the Patuxent and Little Patuxent Rivers. The distinction between terrace deposits and alluvial deposits is made based on elevation/topography, with the older Quaternary-Pleistocene terrace deposits encountered at higher elevations and the Quaternary-Holocene alluvial deposits encountered in and near the lower flood plain areas.

Where encountered, the terrace deposits sit directly on the sand deposits associated with the UPA, except along the hydrogeologic boundary between Hydrogeologic Areas A and B (See Section 8.3.4 below), where the terrace deposits lay directly on the MCU. In most locations, the primary matrix material associated with the terrace deposits was described as sand, silt or a varying combination of both, and the deposits commonly exhibit interlayering with clay or gravel ranging from a couple of inches to about a foot. Thicknesses of the terrace deposits ranged from 4 feet (B-7) to 30 feet (B-14).

8.3.4 Hydrogeologic Areas

Based on the foregoing, the site was divided into two hydrogeologic areas based on formation and soils types. The sections below provide a description of each. Hydrogeologic Map and Cross-Sections from the Phase II Permit Application are included in Attachment 8A for reference.

8.3.4.1 Hydrogeologic Area A

Hydrogeologic Area A is located in the northern and eastern part of the site (Cells 2, 3, and 11 through 16, per Drawing 2). This area can be seen on Cross-Section D-D' from the Phase II Report, replicated in Attachment 8A. As can be seen in Cross-Section D-D', the soils types change appreciably from west to east, where the clay layer associated with the Middle Confining Unit (MCU) thins and practically disappears. The sandy soils, with interbedded silty soils, of the Upper Patapsco Aquifer and the Quarternary Deposits of sand and silt comprise the soils expected to be disturbed as part of the cell construction. There sand and silty soils extends to depths of at least 50 feet below the rubble landfill cell floor.

These materials are suitable and may be appropriate for re-use on-site as structural fill and leachate collection layer soils. Soils types should be sorted as excavated from the construction areas and classified to confirm re-use is allowed on-site.

8.3.4.2 Hydrogeologic Area B

Located in the southwestern part of the site (Cells 1,and 4 through 10, per Drawing 2), this area is underlain by a thick clay bed that extends to depths of at least 100 feet below the rubble landfill cell floor. This areas can be viewed one Hyrdogeologic Sections A-A' and B-B' from the Phase II Permit Application (replicated in Attachment 8A). As can be seen in both sections, the area has the following:

- A small area of Magothy sands in the southern western and of the site underlain by the remnants of an exposed clay area, within the limits of previous mining activities.
- The surficial clay and Magothy sands disappear after the lower third of the site, as you move further north along the sections.
- The middle third of the site has sands exposed at the surface.

As can be seen by the proposed bottom of the landfill line (blue) shown on these Cross-Sections, the current landfill grading does not penetrate the maximum predicted Unconfined Water Bearing Zone, so the majority of the soils to be excavated on-site are sands with silt.

Limited clayey soils will be available as part of the excavation of the floor for Cells 6, 7 and 8. These are among the final cells to be constructed and filled.

8.4 Soil and Aggregate Construction Materials

On-site and off-site sources of soils and aggregate will be required for rubble landfill construction and operation. These materials are characterized as follows:

8.4.1 Fill

Fill for landfill construction consists of soil materials for elevating site grades, constructing perimeter berms, perimeter roads, sediment/stormwater basins, or backfilling excavations. Most of the on-site soils may be used as fill. Unsuitable soils for use as fill are soils containing deleterious materials, highly organic materials, and/or frozen materials. The Fill material maximum dry density shall be determined by Standard Proctor (ASTM D 698) analyses.

8.4.2 Prepared Cell Subbase Soil

The prepared subbase is the 24-inch thick layer of low permeability (<1 x 10^{-5} cm/sec) soil underlying the geosynthetic liner components. Material proposed for use as subbase soil shall meet the requirements of Specification Section 02225.

Subbase construction will require excavation and removal of soils to the bottom of the proposed subbase. The bottom of the subbase surface shall be constructed to a minimum slope of 3.0% to accommodate for potential future differential settlement. The exposed subgrade shall be proof rolled and backfilled as required by the Specifications and CQA Plan.

With the cell floor grades remaining above the unconfined (perched) groundwater, the amount of on-site soils available for the COMAR required 1 x 10^{-5} cm/sec subbase soil layer is expected to be limited and may require amending with clay soils generated on-site and/or imported clayey materials.

8.4.3 Leachate Collection Layer

Leachate Collection Layer is required to be a higher permeability soils under the COMAR-required liner system. A wide range of soils may be suitable for this layer, including a “clean” sand to a “dirty” sand, as long as the requirements listed in the Technical Specifications for this material are met. Soils removed during excavation of the disposal cells are expected to meet these requirements, although some material separation (such as screening) may be necessary to remove finer soil particles. If necessary, off-site sources can be identified and brought to the site.

The leachate collection headers and laterals in the leachate collection layer will be located in an envelope of stone wrapped with a nonwoven geotextile for layer separation from the leachate collection layer, to prevent clogging with smaller particle-size soils, and to provide additional cushion between the stone and the geosynthetic products to prevent puncture. This stone will have to be obtained from off-site.

8.4.4 Select Waste

Pursuant to COMAR Sec. 26.04.07.18. the Select Waste placed over the Leachate Collection Layer will be a minimum of 4 feet of waste containing no long pipes, boards, or other materials that could damage the liner or leachate collection system. The Select Waste shall be placed as two - 2 foot thick lifts (4 feet total thickness) over the geotextile visual barrier/separation layer covering the 2 feet thick leachate collection system layer. The purpose of the protective layer is to minimize the risk of damage to the liner and the leachate collection systems. There are requirements for the material used for this layer in the project Technical Specifications.

8.4.5 Periodic Cover Material

COMAR Sec. 26.04.07.18(F) defines periodic cover material as a uniform compacted layer of clean earth at least 6 inches in depth, or an approved cover material of a thickness specified by the Approving Authority. The cited regulation requires that periodic cover material be placed over all exposed rubble waste by the end of the third day's operation, or more frequently as may be determined by the Approving Authority. An approved cover material may not:

> (1) Contain free liquids, putrescibles, or toxic materials. Moisture present in the cover material solely as a result of precipitation is not free liquid.
>
> (2) Create a dust or odor problem.
> (3) Attract or harbor vectors.
> (4) Impede compaction with standard landfill equipment.

Section 12 of this Phase III Permit Application provides additional information regarding soil material, placed in 6-inch thickness over rubble waste on a regular basis during landfill operations.

8.4.6 Intermediate Cover Soil

Pursuant to COMAR Sec. 26.04.07.18(G) intermediate cover soil is a uniform compacted layer of clean earth not less than 1 foot in depth placed over each lift not later than 1 month following completion of that lift. Procedures for placement of Intermediate cover soil are provided in Section 12 of this Phase III Permit Application.

8.4.7 Final Cover Layer

Pursuant to COMAR Sec. 26.04.07.19(E)(5), the Cover layer will be a 2 feet (min) uniform compacted layer of earthen material placed over the final lift of the filled landfill, not greater than 90 days following completion of fill activities. The Final Cover layer surface will be in direct contact with the geosynthetic components of the Closure Cap. Final Cover Specifications are provided in Section 02229. The Final Cover surface shall be uniform and smooth, without sticks, stones or other objects that could damage to Closure Cap geosynthetics. The finished Final Cover surface shall be approved by the liner installer and QAC.

8.4.8 Closure Cap

The proposed Closure Cap includes a vegetative layer, protective cover soil layer and barrier layer. The barrier component is a synthetic geomembrane and geocomposite drainage layer. The Closure Cap is detailed on Drawing 34. The soil components of the Closure Cap shall be as follows:

8.4.8.1 Closure Cap Protective Cover

The Closure Cap protective cover soil layer shall be Structural Soil Fill (Specification Section 02223) with a maximum particale size of 2 inches, placed in a single 18-inch thickness over the Closure Cap geosynthetic components. Most on-site soils excavated during construction of the disposal cells are expected to meet these requirements.

8.4.8.2 Vegetative Support Layer

The 6-inch thick layer of material to be placed atop the protective cover to support growth of vegetation for permanent erosion control of the closure cap is the Vegetative Support Layer. The vegetative support layer shall meet the requirements of Specification 02235.

8.5 Soil Volume

AutoCAD computer software was utilized to determine soil excavation and fill quantities required to construct the landfill to bottom of cell subbase grade and complete grading outside the landfill footprint shown on Drawings 6 and 7. Existing soil to be removed and fill material required to achieve this construction is the following:

- West Section Cell Area (within inside top of perimeter berm)= 83.8 acres
- West Section Cell Area Excavation = 1,585,000 cy
- West Section Cell Area Fill = 392,000 cy
- West Section Perimeter Area (outside West Section Cell Area)= 27Acres
- West Section Perimeter Area Excavation = 207,000 cy
- West Section Perimeter Area Fill = 115,000 cy
- East Section Cell Area (within inside top of perimeter berm)= 30.6 acres
- East Section Cell Area Excavation = 829,000 cubic yards
- East Section Cell Area Fill = 9,000 cy
- East Section Perimeter Area (outside East Section Cell Area)= 36 Acres
- East Section Perimeter Area Excavation = 306,000 cy
- East Section Perimeter Area Fill = 257,000 cy

Amount of Excavation = 1,585,000 + 207,000 + 829,000 + 306,000
= 2,927,000 cubic yards

Amount of Fill = 392,000 + 115,000 + 9,000 + 257,000
= 773,000 cubic yards

Net Excavation/Fill Amount = 2,154,000 cubic yards of excess excavation

Drawings 36 and 37 show Landfill Cross-Sections with the existing grades, proposed top and bottom of subgrade, and top of final cover grading superimposed.

Based on the information presented on these landfill cross-sections, the majority of the West Section excavation is in Hydrogeologic Area B (Cells 5A through 9), where existing ground elevation is rising in a southerly direction and highest anticipated groundwater elevation is relatively low. Fill proposed in the West Section (at the north end of Cells 1, 2, and 3) is attributed to a higher groundwater elevation at the transition along the Hydrogeologic Areas A and B interface.

Excavation volume for East Section landfill cells in Hydrogeologic Area A (with surface area approximately one-third of the West Section's surface area) is equivalent to approximately 35% of West Section excavation.

8.6 Total Disturbance

Disturbed area to construct the facility, including all appurtenances (i.e., perimeter access road, leachate conveyance and storage systems, sediment basins, etc.) is 60.5 in the East Section (which includes Sediment Basin Nos. 1 and 2, and Leachate Storage Area No. 1) and 132.7 acres in the West Section, which includes the remainder of the facility. Excavation and fill will be required to construct landfill appurtenances, as indicated on Sediment Control Plans (Drawings 55 through 62).

8.7 Available Soils

Initial stage construction for site infrastructure is comprised of the following components:

- Stormwater management facilities;
- Site entrance road and scales;
- Maintenance and office building;
- Perimeter access road;
- Perimeter ditches; and
- Leachate collection facilities.

Following construction of site infrastructure facilities, landfill cells will be constructed as specified on Drawing 63, "Sequence and General Notes for Construction" and Intermediate Construction Stage Drawings 64 through 81.

Throughout the life of landfill construction and operation, it is anticipated that the on-site quantity of topsoil salvaged from clearing operations will be sufficient to promote vegetative stabilization on rubble waste soil cover and other graded areas, as necessary.

The on-site quantity of soil, from excavations for cell construction and appurtenances, is anticipated to be sufficient to meet COMAR requirements for rubble waste soil cover. Rubble waste soil cover includes:

- 2-feet of prepared subbase
- 2-feet of leachate collection layer materials
- 2-feet of Final Cover; and
- 18-inch depth closure cap protective cover
- 6-inch depth vegetative support layer

From Section 5.1, total design capacity of the landfill is approximately 9.3 million cubic yards (MCY). It is estimated that approximately 10% of the design capacity (i.e., 0.93 million cubic yards) will be comprised of rubble waste soil cover.

Surface area of the landfill cells is approximately 114.4 acres. The estimated volume of soil required for the landfill's soil layers is then calculated as follows (answers are rounded to nearest thousand c.y.):

Volume of Prepared Subbase Layer = (114.4 acres) (43,560 cubic feet/acre) (2 feet)
= 9,966,528 cubic feet (1 c.y./27 cubic feet)
= 369,000 c.y.

Volume of Leachate Collection Layer = (114.4 acres) (43,560 cubic feet/acre) (2 feet)
= 9,966,528 cubic feet (1 c.y./27 cubic feet)
= 369,000 c.y.

Volume of Final Cover = (114.4 acres) (43,560 cubic feet/acre) (2 foot)
= 9,966,528 cubic feet (1 c.y./27 cubic feet)
= 369,000 c.y.

Volume of Cap Protective Cover = (114.4 acres)(43,560 cubic feet/acre)(1.5 feet)
= 7,474,896 cubic feet (1 c.y./27 cubic feet)
= 277,000 c.y.

Volume of Vegetative Support Layer = (114.4 acres)(43,560 cubic feet/acre)(0.5 feet)
= 2,491,632 cubic feet (1 c.y./27 cubic feet)
= 92,000 c.y.

Total Volume of = Daily/periodic cover + Final Cover + Leachate Collection Layer + material needed + Protective Layer + Intermediate Cover + Protective Cover + Vegetative Support Layer
= 930,000 + 369,000 + 369,000+ 369,000 + 277,000 + 92,000
= 2,406,000 c.y.

This volume exceeds the amount of material available from the excavations required to achieve cell and perimeter grading by approximately 250,000 c.y.

Other options for the periodic cover may include obtaining approval of alternate cover which may include temporary tarps, lightly impacted soils, coal combustion residuals (i.e., primarily coal ash), among others.

The Operations Plan under Section 12.7.7 specifies that each working face will have an approximate area of 1 acre and up to 3 active working faces. Stockpiles maintained to contain sufficient volume of periodic cover for continual placement on active cell working faces over a 7 day time frame will be provided. Whereas 6-inch depth periodic cover will be placed over the entire area of a 1-acre working face every three days, the quantity of periodic cover sufficient for 7 days placement over 3 working faces is calculated as follows:

Week Supply of Periodic Cover = (7 days/3 days) (43,560 square feet/acre) (0.5 feet)
(3 acres) = 152,460 cubic feet

Volume of soil contained in a 20 feet high stockpile, having 2:1 side slopes and covering a 100 feet by 150 feet surface area, is calculated as follows:

Stockpile Volume = [(100 feet) (150 feet) + (60 feet) (110 feet)] (1/2) (20 feet)
= 216,000 cubic feet

Per the description of cell working faces and calculation for a single stockpile area capable of maintaining continual periodic cover provision during the life of landfill construction and operation, depiction of 100 feet by 150 feet surface area rubble waste soil cover stockpiles for landfill cells (excluding Cells 6 and 7) is shown on Drawings 64 through 81.

Because the rubble waste soil cover stockpile for Cells 6 and 7 will likely be relocated along the east side of the adjacent temporary access road during the waste placement operation in the cells, a rubble waste soil cover stockpile is not shown on those Drawings.

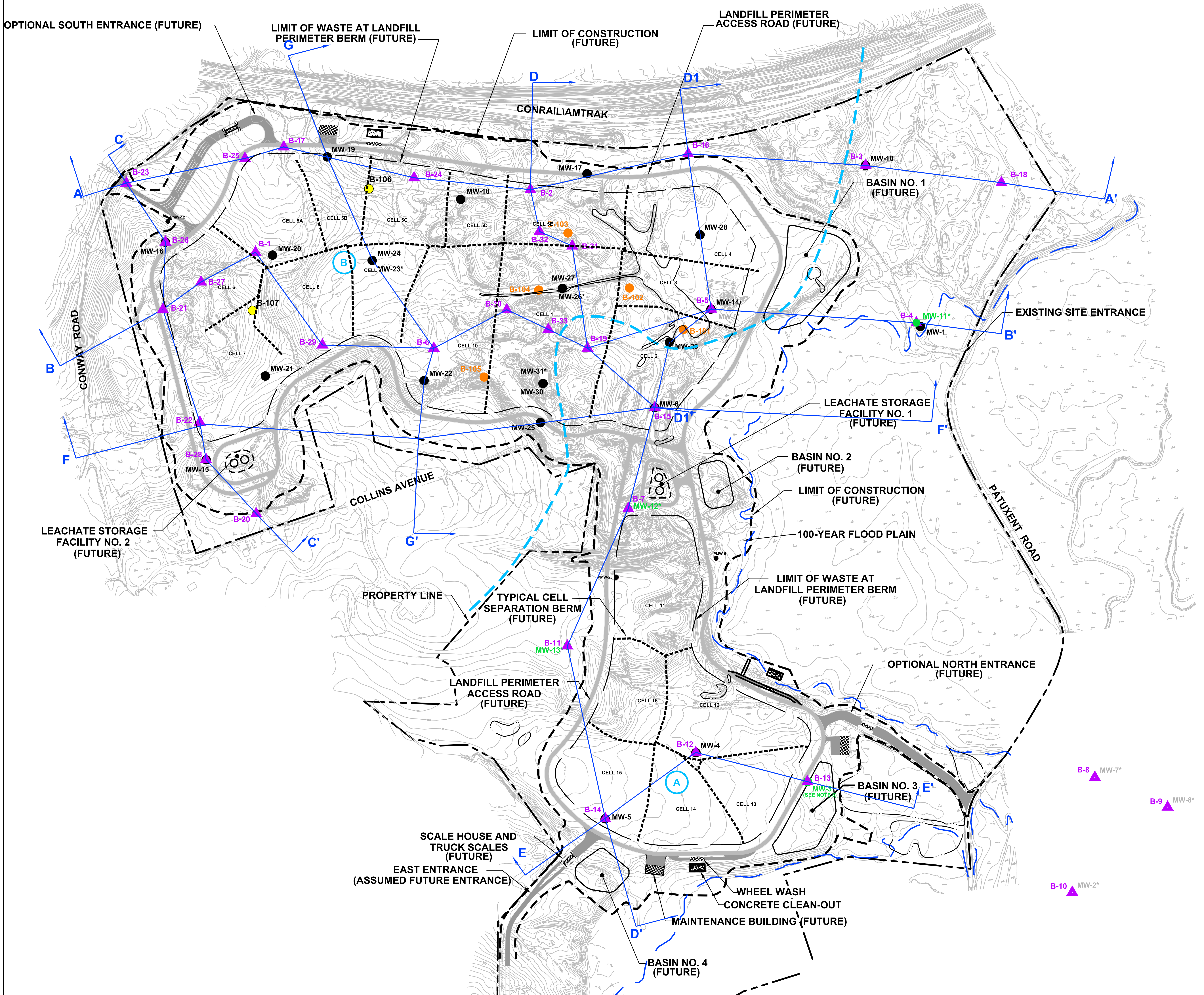
Dependent upon the stage of the waste placement operation, rubble waste soil cover stockpiles for periodic cover may also be used for provision of intermediate cover. Location of stockpiles shown on the Drawings is based on the following criteria:

- Proximity to active cell;
- Proximity to temporary access roads; and
- Proximity to surface runoff diversionary measures.

The landfill operator is not restricted to rubble waste soil cover stockpile locations shown on the Drawings.

ATTACHMENT 8A

Plan and Hydrogeologic Cross-Sections from the Phase II Permit Application



LEGEND

— · —	PROPERTY LINE
▬	LANDFILL PERIMETER ACCESS ROAD (FUTURE)
▬	SITE ENTRANCE (FUTURE)
— — —	LANDFILL LIMITS (FUTURE)
············	LANDFILL CELL SEPARATION BERM (FUTURE)
– – – –	LIMIT OF DISTURBANCE (FUTURE)
— — —	100-YEAR FLOOD PLAIN (AFTER 2012) (SEE REFERENCE 2) (SEE NOTE 4)
— — —	JURISDICTIONAL DETERMINATION (JD) WETLANDS BOUNDARY (APPROX.) WITH IDENTIFICATION AND AREA (SEE NOTE 5)
●	MONITORING WELL (MONITORING WELLS MARKED WITH AN * ARE LOST, DAMAGED OR MCU WELL NOT SUBJECT TO MONITORING
▲	HISTORICAL BOREHOLES (SEE REFERENCE 3)
●	BORING LOCATIONS TO REFINE AREA A-B TRANSITION (B-101 TO B-105) COMPLETED APRIL/MAY 2013
●	ADDITIONAL BORINGS LOCATIONS REQUESTED BY MDE (B-106 AND B-107) COMPLETED APRIL/MAY 2013
— — —	HYDROGEOLOGIC AREA DIVIDE (SEE NOTE 3)
Ⓐ	HYDROGEOLOGIC AREA (SEE NOTE 3)
A└─┘A'	GEOLOGIC CROSS SECTION ALIGNMENT (SEE FIGURES 5 THROUGH 11)

REFERENCES

1.) BASEMAP SHOWN, INCLUDING TOPOGRAPHICAL INFORMATION, IS FROM DIGITAL FILE (2 OF 68) SITE PLAN.DWG, ENTITLED "SITE PLAN," PREPARED BY CENTURY ENGINEERING, INC., DATED APRIL 12, 2010.

2.) MONITORING WELL LOCATIONS DIGITIZED FROM HARD COPY OF DRAWING ENTITLED "PERMANENT GROUNDWATER MONITORING WELL PLAN," PREPARED BY CENTURY ENGINEERING, INC., DATED MAY 2008.

3.) ADDITIONAL HISTORICAL BORING LOCATIONS FROM HARD COPY OF DRAWING ENTITLED "PLATE 2, CHESAPEAKE RUBBLE LANDFILL HYDROGEOLOGIC BASE MAP," DATED NOVEMBER 2003, CREATED BY MARK SCHULTZ ASSOCIATES, ANNAPOLIS, MARYLAND.

NOTES

1.) THE FUTURE RUBBLE LANDFILL DEVELOPMENT FEATURES ARE INCLUDED TO SHOW LOCATION OF THE BORINGS AND MONITORING WELLS RELATIVE TO THE PROPOSED DEVELOPMENT. THE ACTUAL LIMITS OF FUTURE DEVELOPMENT MAY BE ADJUSTED AS PART OF THE DETAILED ENGINEERING DESIGN TO BE INCLUDED IN THE PHASE III PERMIT APPLICATION, WHICH IS CURRENTLY UNDERGOING REVISION.

2.) GEOLOGIC CROSS SECTIONS ARE PRESENTED ON FIGURES 5 THROUGH 11.

3.) HYDROLOGIC AREAS AND THEIR MAPPING IS BASED ON FORMATIONS MAPPED IN FIELD BOREHOLES, SURFACE OBSERVATION, HISTORICAL AERIAL PHOTOGRAPHS, AND REGIONAL GEOLOGIC MAPS.

4.) THE 100-YEAR FLOODPLAIN LIMITS ARE BASED ON 2012 FEMA STUDY.

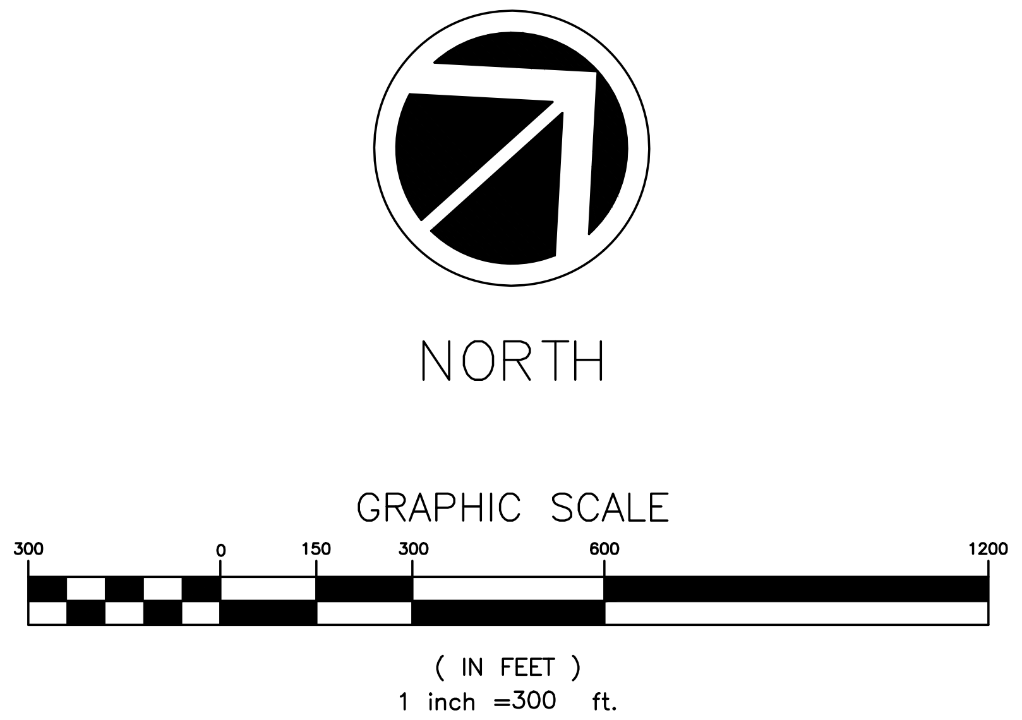
5.)THE CONRAIL TRACKS ARE ALSO SHARED WITH AMTRAK FOR HIGH-SPEED COMMUTER TRAINS BETWEEN BOSTON, MASSACHUSETTS, AND WASHINGTON, D.C.

6.) THE PROPERTY WAS PREVIOUSLY USED FOR SAND AND GRAVEL MINING ACTIVITIES. PORTIONS OF THE SITE CURRENTLY HAVE NO VEGETATION AND ARE BARREN.

7.) THE SITE IS NOT SECURE FROM TRESPASSERS. SEVERAL MONITORING WELLS HAVE BEEN DAMAGED BY VANDALS.

8.) ON-SITE MONITORING WELLS MW-3, 11, 12, AND 13, AND OFF-SITE WELLS MW-2, 7, AND 8 ARE NO LONGER SUITABLE/ACCESSIBLE FOR DEPTH TO WATER MEASUREMENTS AND SAMPLING

9.) THE PROPOSED LANDFILL PERIMETER ROAD BERM GRADES ARE PROPOSED A MINIMUM OF 5 FEET ABOVE THE FEMA BASE FLOOD ELEVATIONS.



VERONICA E. FOSTER
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MD # 35645

DATE:	REVISION:
4/30/2020	REVISED TO ADDRESS MDE COMMENTS (PGS/VEF)
6/5/2020	EDITORIAL REVISIONS/NEW LANDFILL BOTTOM (PGS/VEF)

NATIONAL WASTE MANAGERS
PHASE II PERMIT APPLICATION
CHESAPEAKE TERRACE RUBBLE LANDFILL
PATUXENT ROAD, ODENTON
ANNE ARUNDEL COUNTY, MARYLAND

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ON-SITE BORING AND WELL
LOCATIONS MAP

REPORT CODE: A	FILE NAME: 20183854A004
PROJECT MANAGER: VEF	SCALE: AS NOTED
CHECKED BY: VEF	PROJECT NUMBER: 2018-3854
DRAWN BY: EEE	DATE: 4/1/2019

FIGURE 4

REFERENCES

1.) THE SURFACE GRADES SHOWN ARE FROM DIGITAL FILE (2 OF 68) SITE PLAN.DWG, ENTITLED "SITE PLAN," PREPARED BY CENTURY ENGINEERING, INC., DATED APRIL 12, 2010.

2.) BORING LOGS ARE PROVIDED IN APPENDICES E AND F IN PHASE II APPLICATION HYDROGEOLOGIC REPORT, DATED JUNE 5, 2020, PREPARED BY ADVANCED GEOSERVICES CORP.

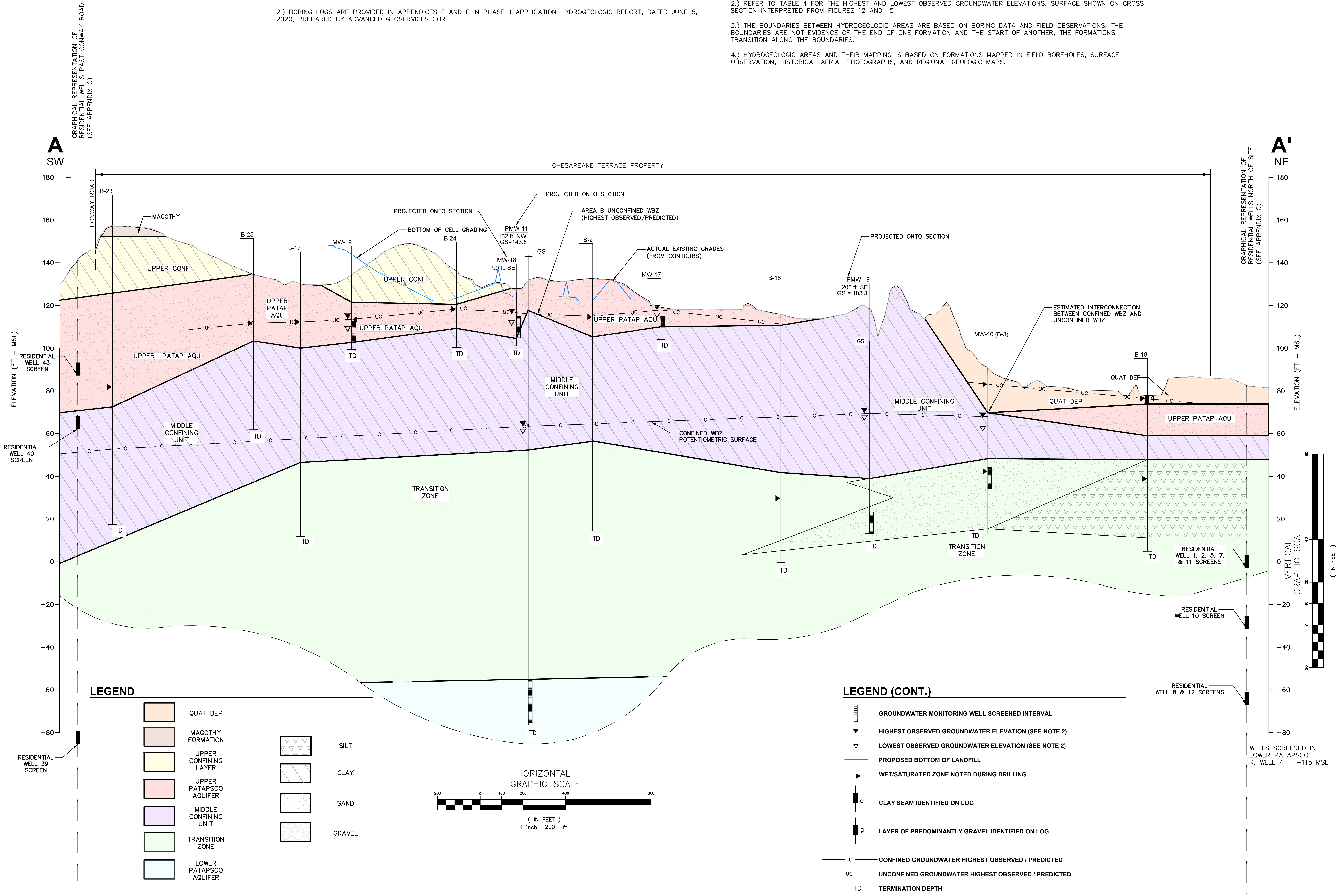
NOTES

1.) REFER TO FIGURE 4, ON–SITE BORING AND WELL LOCATIONS MAP, FOR THE GEOLOGIC CROSS SECTION LOCATIONS.

2.) REFER TO TABLE 4 FOR THE HIGHEST AND LOWEST OBSERVED GROUNDWATER ELEVATIONS. SURFACE SHOWN ON CROSS SECTION INTERPRETED FROM FIGURES 12 AND 15

3.) THE BOUNDARIES BETWEEN HYDROGEOLOGIC AREAS ARE BASED ON BORING DATA AND FIELD OBSERVATIONS. THE BOUNDARIES ARE NOT EVIDENCE OF THE END OF ONE FORMATION AND THE START OF ANOTHER, THE FORMATIONS TRANSITION ALONG THE BOUNDARIES.

4.) HYDROGEOLOGIC AREAS AND THEIR MAPPING IS BASED ON FORMATIONS MAPPED IN FIELD BOREHOLES, SURFACE OBSERVATION, HISTORICAL AERIAL PHOTOGRAPHS, AND REGIONAL GEOLOGIC MAPS.



LEGEND

- QUAT DEP
- MAGOTHY FORMATION
- UPPER CONFINING LAYER
- UPPER PATAPSCO AQUIFER
- MIDDLE CONFINING UNIT
- TRANSITION ZONE
- LOWER PATAPSCO AQUIFER
- SILT
- CLAY
- SAND
- GRAVEL

LEGEND (CONT.)

- GROUNDWATER MONITORING WELL SCREENED INTERVAL
- ▼ HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
- ▽ LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
- PROPOSED BOTTOM OF LANDFILL
- ▶ WET/SATURATED ZONE NOTED DURING DRILLING
- c CLAY SEAM IDENTIFIED ON LOG
- g LAYER OF PREDOMINANTLY GRAVEL IDENTIFIED ON LOG
- — C — CONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
- — UC — UNCONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
- TD TERMINATION DEPTH

VERONICA E. FOSTER
LICENSED PROFESSIONAL ENGINEER
LIC. NO. 35645

DATE:	REVISION:
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6/5/2020	EDITORIAL REVISIONS/NEW LANDFILL BOTTOM (PGS/VEF)

NATIONAL WASTE MANAGERS
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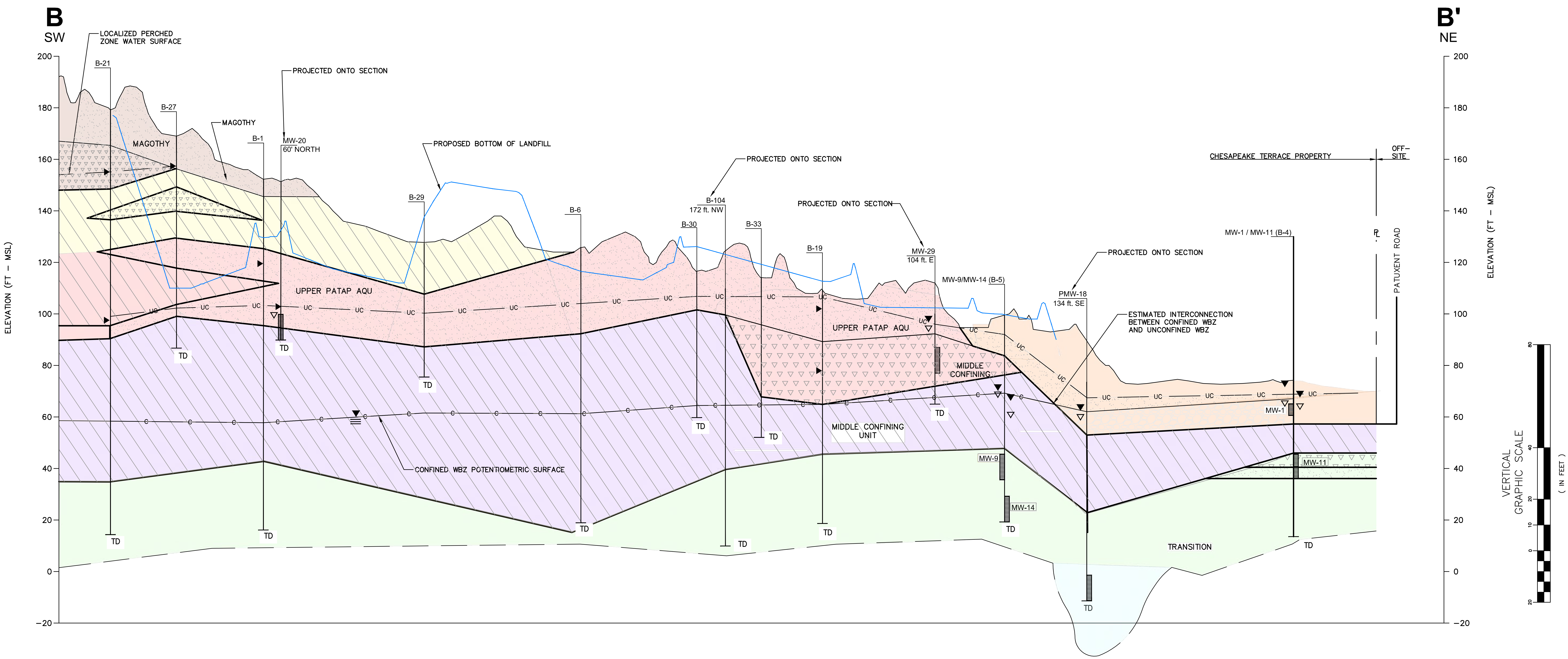
GEOLOGIC CROSS SECTION A–A'

REPORT CODE: A	FILE NAME: 20183854A005
PROJECT MANAGER: VEF	SCALE: AS NOTED
CHECKED BY: VEF	PROJECT NUMBER: 2018–3854
DRAWN BY: EEE	DATE: 4/1/2019

FIGURE 5

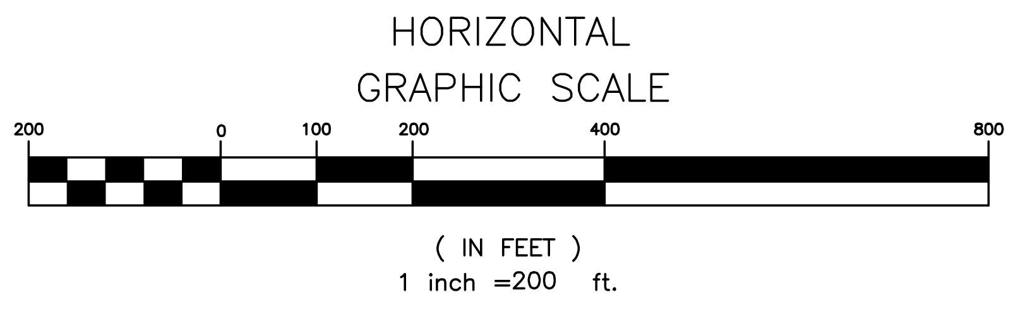


LEGEND

- GROUNDWATER MONITORING WELL SCREENED INTERVAL
- ▼ HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
- ▽ LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
- PROPOSED BOTTOM OF LANDFILL
- ▶ WET/SATURATED ZONE NOTED DURING DRILLING
- c CLAY SEAM IDENTIFIED ON LOG
- g LAYER OF PREDOMINANTLY GRAVEL IDENTIFIED ON LOG
- —— C —— CONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
- —— UC —— UNCONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
- TD TERMINATION DEPTH

- ▽ SILT
- ▨ CLAY
- ░ SAND
- ○ GRAVEL

- 🟧 QUAT DEP
- 🟫 MAGOTHY FORMATION
- 🟨 UPPER CONFINING LAYER
- 🟥 UPPER PATAPSCO AQUIFER
- 🟪 MIDDLE CONFINING UNIT
- 🟩 TRANSITION ZONE
- ⬜ LOWER PATAPSCO AQUIFER



REFERENCES

1.) THE SURFACE GRADES SHOWN ARE FROM DIGITAL FILE (2 OF 68) SITE PLAN.DWG, ENTITLED "SITE PLAN," PREPARED BY CENTURY ENGINEERING, INC., DATED APRIL 12, 2010.

2.) BORING LOGS ARE PROVIDED IN APPENDICES E AND F IN PHASE II APPLICATION HYDROGEOLOGIC REPORT, DATED JUNE 5, 2020, PREPARED BY ADVANCED GEOSERVICES CORP.

NOTES

1.) REFER TO FIGURE 4, ON–SITE BORING AND WELL LOCATIONS MAP, FOR THE GEOLOGIC CROSS SECTION LOCATIONS.

2.) REFER TO TABLE 4 FOR THE HIGHEST AND LOWEST OBSERVED GROUNDWATER ELEVATIONS. SURFACE SHOWN ON CROSS SECTION INTERPRETED FROM FIGURES 12 AND 15

3.) THE BOUNDARIES BETWEEN HYDROGEOLOGIC AREAS ARE BASED ON BORING DATA AND FIELD OBSERVATIONS. THE BOUNDARIES ARE NOT EVIDENCE OF THE END OF ONE FORMATION AND THE START OF ANOTHER, THE FORMATIONS TRANSITION ALONG THE BOUNDARIES.

4.) HYDROGEOLOGIC AREAS AND THEIR MAPPING IS BASED ON FORMATIONS MAPPED IN FIELD BOREHOLES, SURFACE OBSERVATION, HISTORICAL AERIAL PHOTOGRAPHS, AND REGIONAL GEOLOGIC MAPS.

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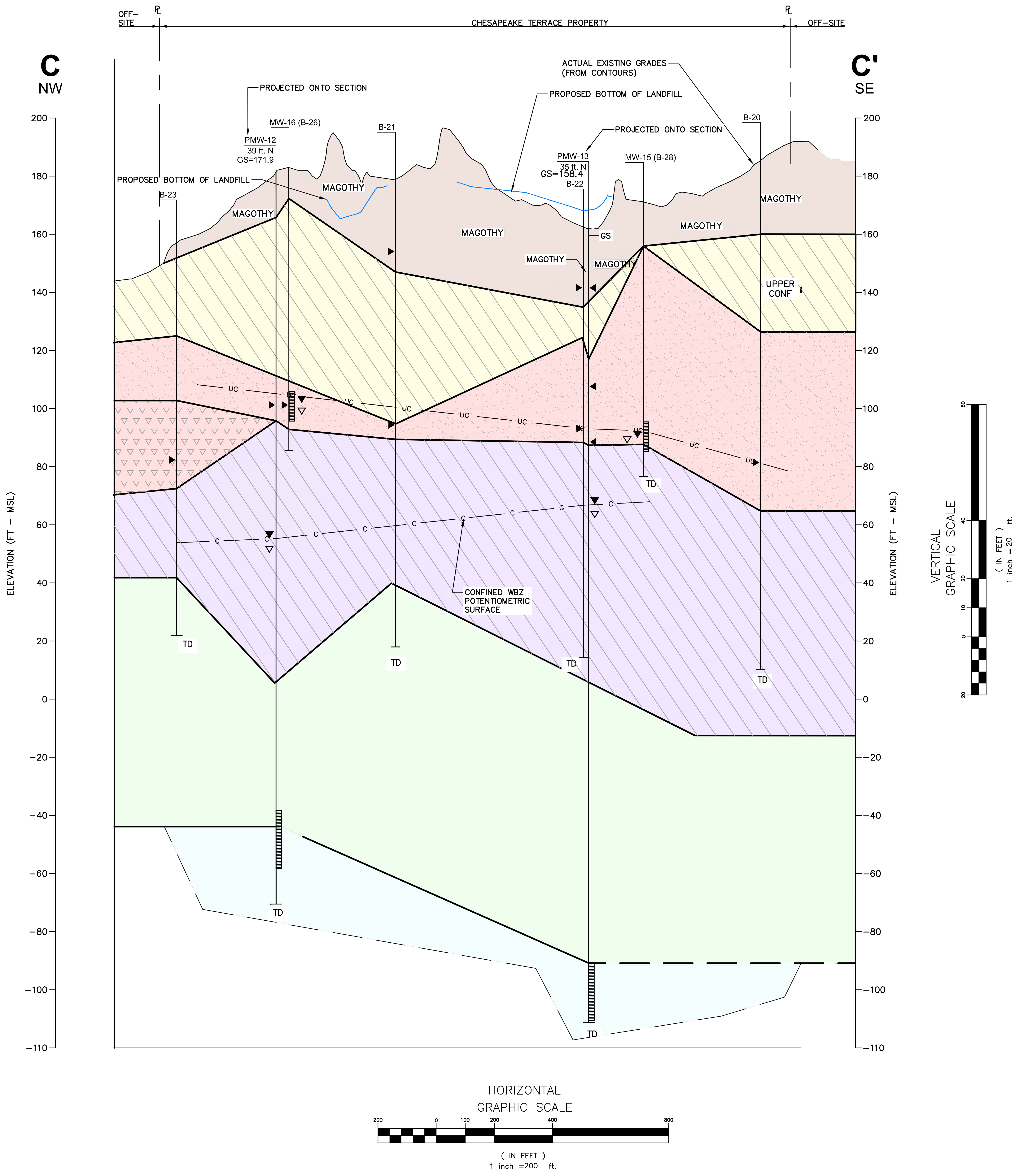
GEOLOGIC CROSS SECTION B–B'

REPORT CODE: A	FILE NAME: 20183854A006
PROJECT MANAGER: VEF	SCALE: AS NOTED
CHECKED BY: VEF	PROJECT NUMBER: 2018–3854
DRAWN BY: EEE	DATE: 4/1/2019

FIGURE 6



LEGEND

▥	GROUNDWATER MONITORING WELL SCREENED INTERVAL
▼	HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
▽	LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
—	PROPOSED BOTTOM OF LANDFILL
▶	WET/SATURATED ZONE NOTED DURING DRILLING
▮ c	CLAY SEAM IDENTIFIED ON LOG
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TD	TERMINATION DEPTH

▽	SILT	🟧	QUAT DEP
▨	CLAY	🟫	MAGOTHY FORMATION
⁘	SAND	🟨	UPPER CONFINING LAYER
◌	GRAVEL	🟥	UPPER PATAPSCO AQUIFER
		🟪	MIDDLE CONFINING UNIT
		🟩	TRANSITION ZONE
		🟦	LOWER PATAPSCO AQUIFER

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4.) HYDROGEOLOGIC AREAS AND THEIR MAPPING IS BASED ON FORMATIONS MAPPED IN FIELD BOREHOLES, SURFACE OBSERVATION, HISTORICAL AERIAL PHOTOGRAPHS, AND REGIONAL GEOLOGIC MAPS.

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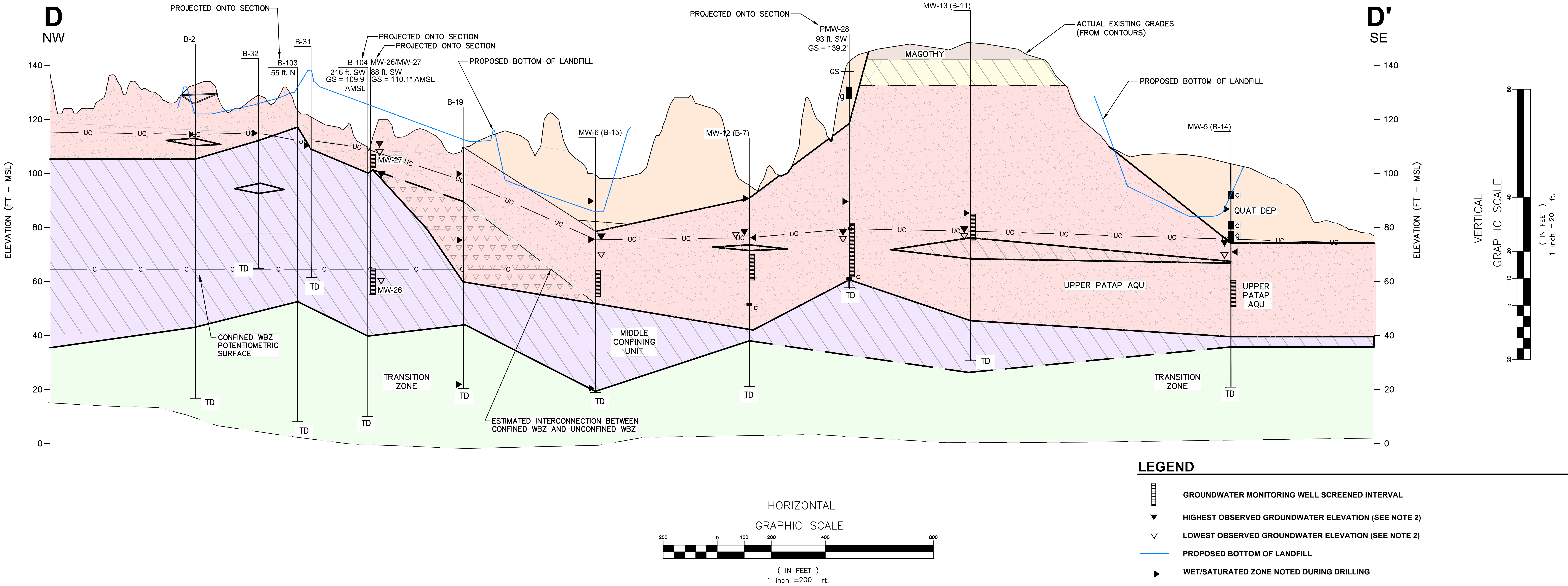
GEOLOGIC CROSS SECTION C–C'

REPORT CODE: A	FILE NAME: 20183854A007
PROJECT MANAGER: VEF	SCALE: AS NOTED
CHECKED BY: VEF	PROJECT NUMBER: 2018-3854
DRAWN BY: EEE	DATE: 4/1/2019

FIGURE 7



LEGEND

▥	GROUNDWATER MONITORING WELL SCREENED INTERVAL
▼	HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
▽	LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
—	PROPOSED BOTTOM OF LANDFILL
▶	WET/SATURATED ZONE NOTED DURING DRILLING
▮ c	CLAY SEAM IDENTIFIED ON LOG
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— c —	CONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
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TD	TERMINATION DEPTH

▽▽▽	SILT
▨	CLAY
░	SAND
▩	GRAVEL

🟧	QUAT DEP
🟫	MAGOTHY FORMATION
🟨	UPPER CONFINING LAYER
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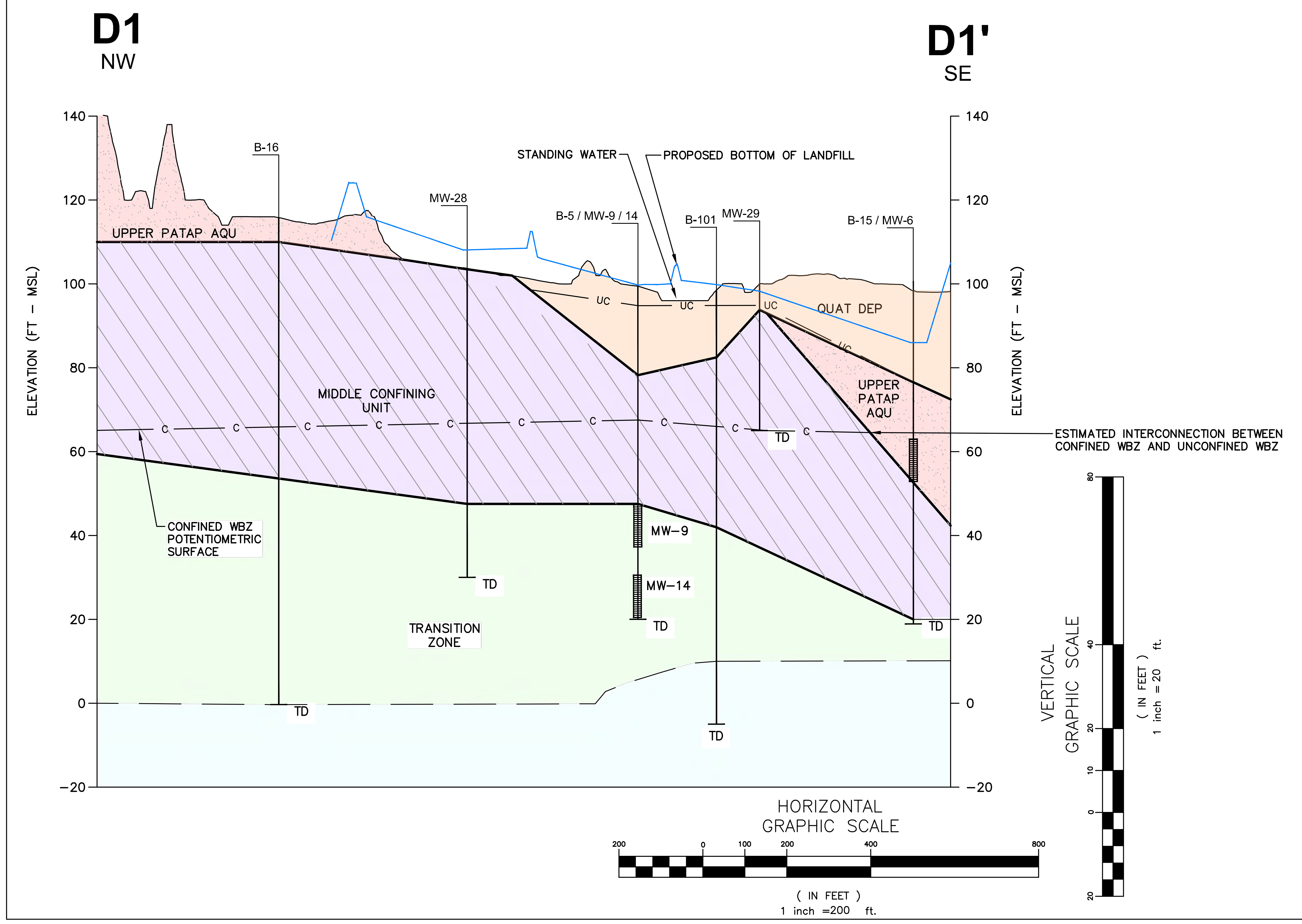
🟩	TRANSITION ZONE
🟦	LOWER PATAPSCO AQUIFER



REFERENCES

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4.) HYDROGEOLOGIC AREAS AND THEIR MAPPING IS BASED ON FORMATIONS MAPPED IN FIELD BOREHOLES, SURFACE OBSERVATION, HISTORICAL AERIAL PHOTOGRAPHS, AND REGIONAL GEOLOGIC MAPS.

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NATIONAL WASTE MANAGERS
PHASE II PERMIT APPLICATION
CHESAPEAKE TERRACE RUBBLE LANDFILL
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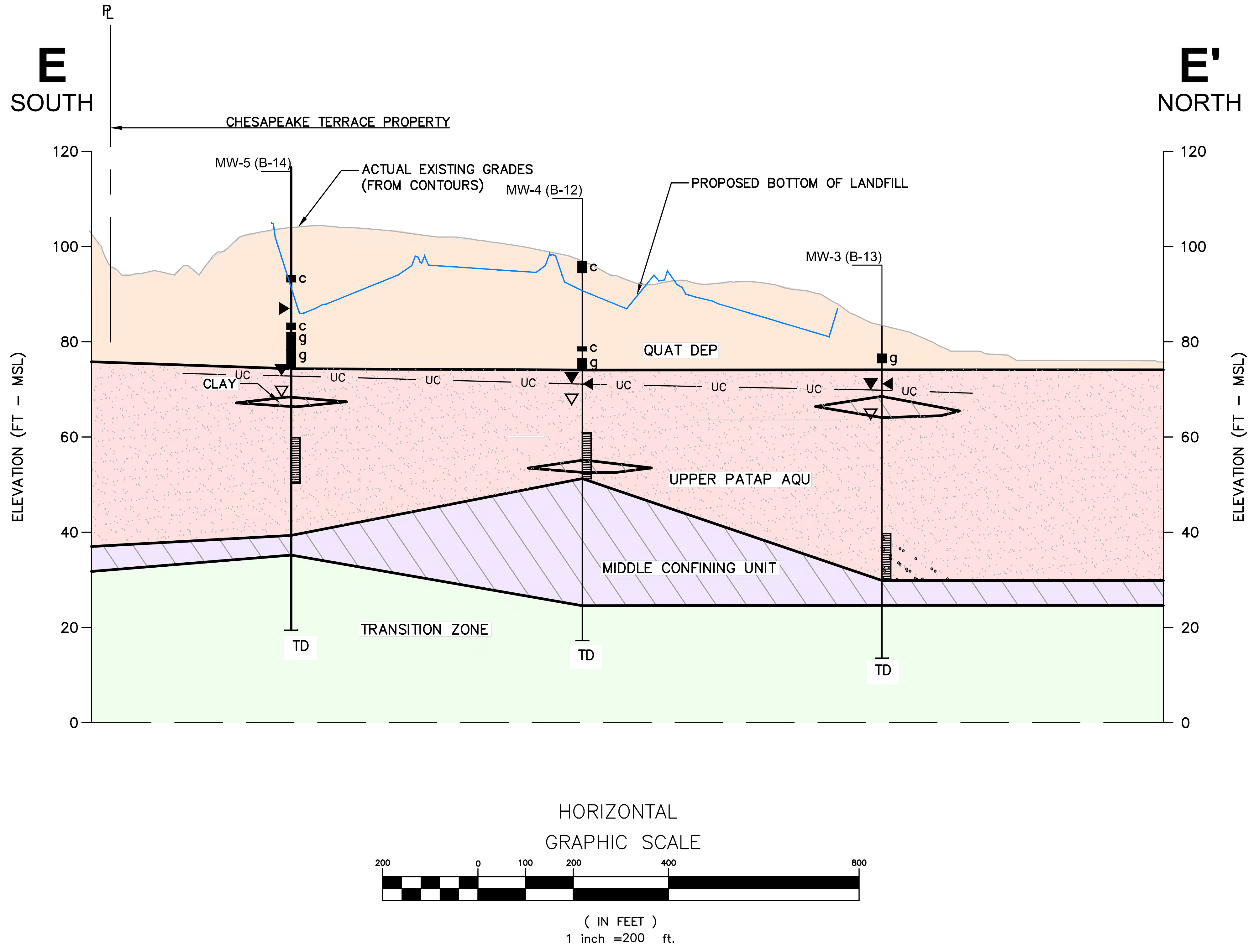
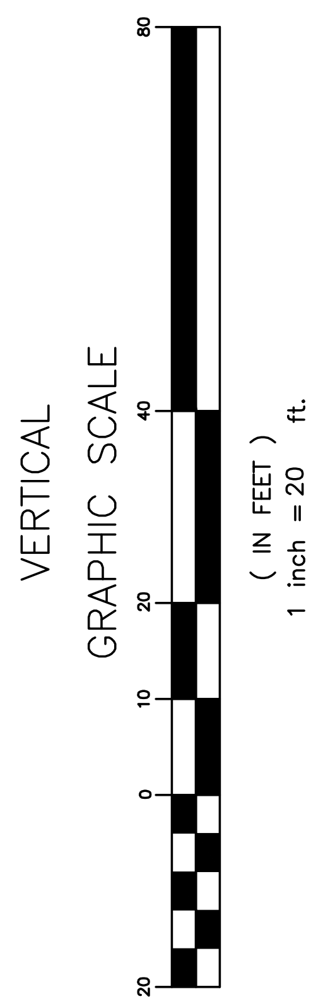
GEOLOGIC CROSS SECTIONS
D–D' AND D1–D1'

REPORT CODE: A		FILE NAME: 20183854A008	
PROJECT MANAGER:	VEF	SCALE:	AS NOTED
CHECKED BY:	VEF	PROJECT NUMBER:	2018–3854
DRAWN BY:	EEE	DATE:	4/1/2019

FIGURE 8





LEGEND

GROUNDWATER MONITORING WELL SCREENED INTERVAL
▼ HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
▽ LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
PROPOSED BOTTOM OF LANDFILL
▶ WET/SATURATED ZONE NOTED DURING DRILLING
c CLAY SEAM IDENTIFIED ON LOG
g LAYER OF PREDOMINANTLY GRAVEL IDENTIFIED ON LOG
—— C —— CONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
—— UC —— UNCONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
TD TERMINATION DEPTH

▽ SILT
▨ CLAY
SAND
GRAVEL

🟧 QUAT DEP
MAGOTHY FORMATION
🟨 UPPER CONFINING LAYER
🟥 UPPER PATAPSCO AQUIFER
🟪 MIDDLE CONFINING UNIT
🟩 TRANSITION ZONE
🟦 LOWER PATAPSCO AQUIFER

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GEOLOGIC CROSS SECTION E–E'

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PROJECT MANAGER: VEF
SCALE: AS NOTED
CHECKED BY: VEF
PROJECT NUMBER: 2018-3854
DRAWN BY: EEE
DATE: 4/1/2019

FIGURE 9

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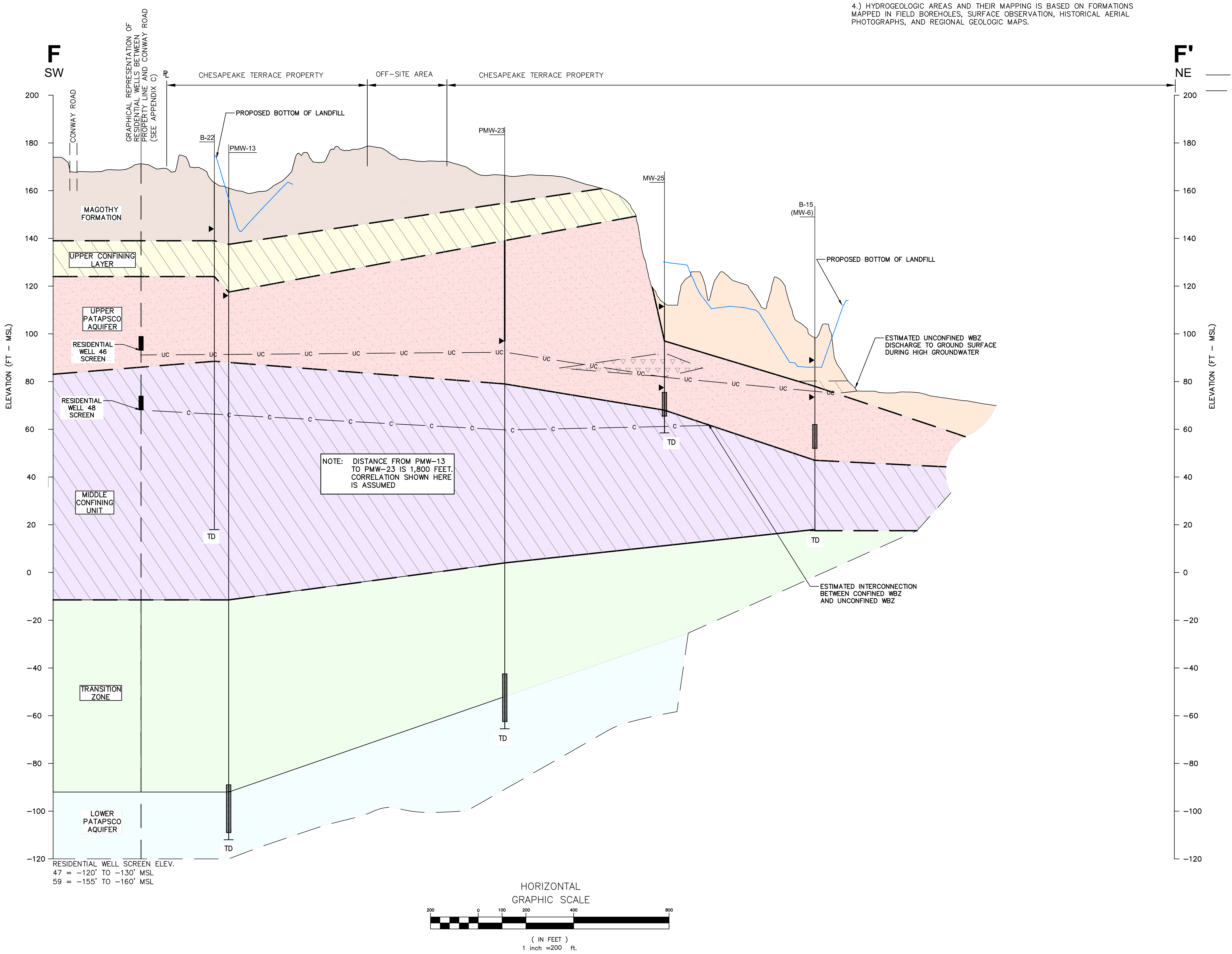


LEGEND

GROUNDWATER MONITORING WELL SCREENED INTERVAL

▼ HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)

▽ LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)

PROPOSED BOTTOM OF LANDFILL

▶ WET/SATURATED ZONE NOTED DURING DRILLING

c CLAY SEAM IDENTIFIED ON LOG

g LAYER OF PREDOMINANTLY GRAVEL IDENTIFIED ON LOG

—— C —— CONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED

—— UC —— UNCONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED

TD TERMINATION DEPTH

SILT

CLAY

SAND

GRAVEL

QUAT DEP

MAGOTHY FORMATION

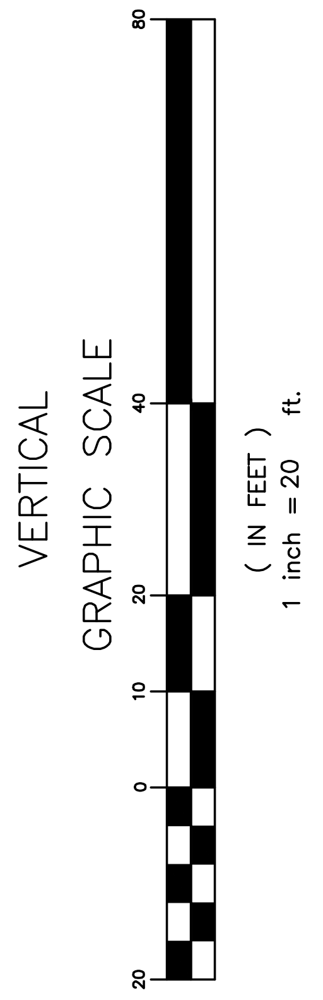
UPPER CONFINING LAYER

UPPER PATAPSCO AQUIFER

MIDDLE CONFINING UNIT

TRANSITION ZONE

LOWER PATAPSCO AQUIFER



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GEOLOGIC CROSS SECTION F–F'

REPORT CODE: A	FILE NAME: 20183854A010
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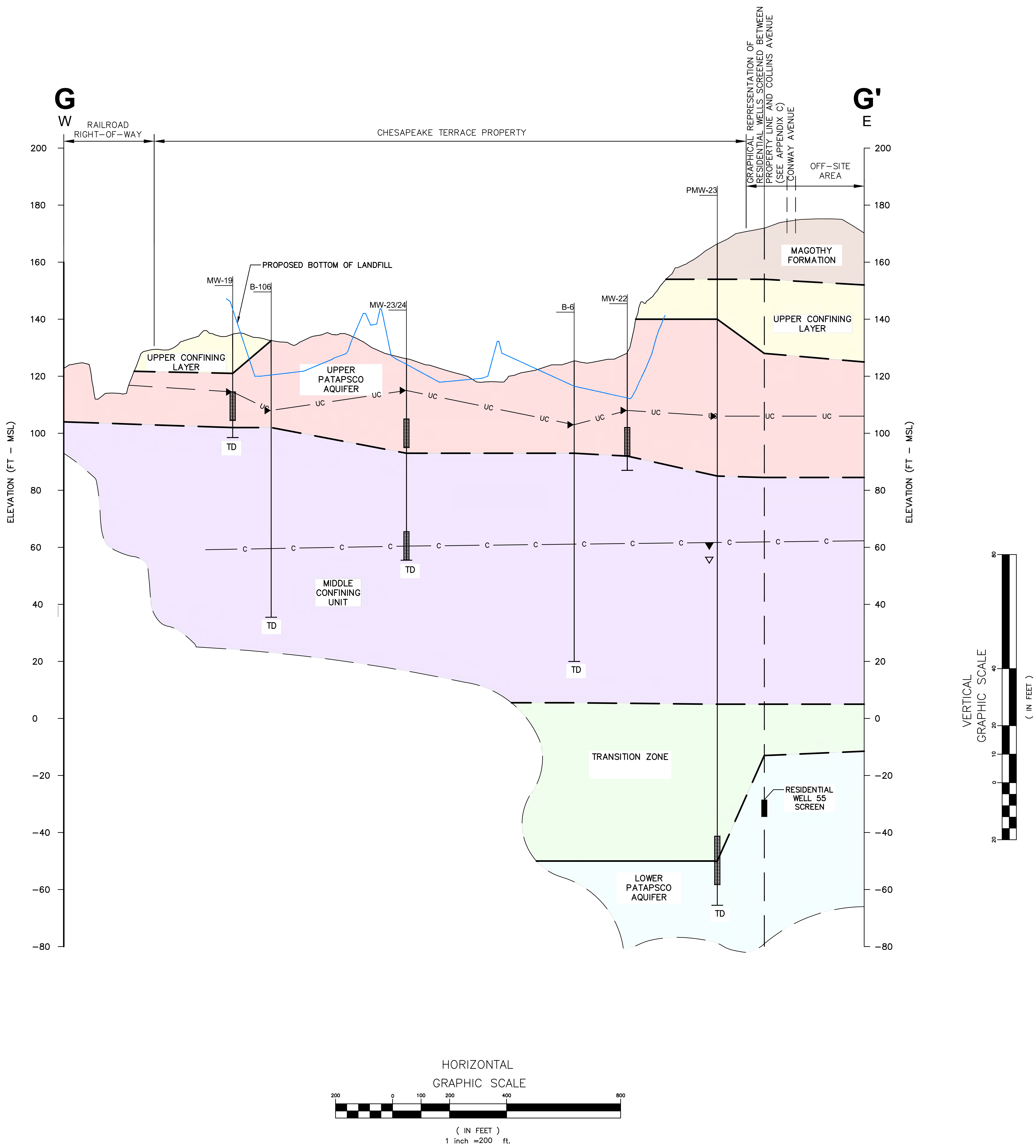
CHECKED BY: VEF	PROJECT NUMBER: 2018–3854
DRAWN BY: EEE	DATE: 4/1/2019

FIGURE 10



LEGEND

- ▮ GROUNDWATER MONITORING WELL SCREENED INTERVAL
- ▼ HIGHEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
- ▽ LOWEST OBSERVED GROUNDWATER ELEVATION (SEE NOTE 2)
- — PROPOSED BOTTOM OF LANDFILL
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- — C — CONFINED GROUNDWATER HIGHEST OBSERVED / PREDICTED
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- TD TERMINATION DEPTH

▨	SILT	🟧	QUAT DEP
▨	CLAY	🟫	MAGOTHY FORMATION
▨	SAND	🟨	UPPER CONFINING LAYER
▨	GRAVEL	🟥	UPPER PATAPSCO AQUIFER
		🟪	MIDDLE CONFINING UNIT
		🟩	TRANSITION ZONE
		🟦	LOWER PATAPSCO AQUIFER

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GEOLOGIC CROSS SECTION G–G'

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CHECKED BY:	VEF	PROJECT NUMBER:	2018–3854
DRAWN BY:	EEE	DATE:	4/1/2019

FIGURE 11

SECTION 9

GEOTECHNICAL CONSIDERATIONS

TABLE OF CONTENTS

LIST OF ATTACHMENTS

9.0 GEOTECHNICAL CONSIDERATIONS

As with any landfill design, there are significant geotechnical engineering considerations to assure that the overall landfill is stable, including the various components – from the placement of waste to the liner and cap systems materials to the ability of the subgrade to support the new mass of material being placed atop it. This Section provides a brief summary of the geotechnical considerations evaluated during the course of the design of the Chesapeake Terrace Rubble Landfill.

9.1 Liner System

9.1.1 COMAR-Required Liner System

COMAR Section 26.04.07.16 (C)(3) requires the design of the liner system to include the following components, from top to bottom:

- Protective Layer: A protective layer of select waste to protect the integrity of the underlying layers;
- Two feet of "gravel or other highly permeable material" to provide for free passage of leachate and to protect the liner; and,
- A "liner constructed with a minimum thickness of 1-foot of clay or other natural material having an in-place permeability of less than or equal to $1x10^{-7}$ cm/sec <u>or</u> one or more unreinforced synthetic membranes with a combined minimum thickness of 50 mil <u>or</u> a single reinforced synthetic membrane with a 30 mil thickness which has a permeability of 1×10^{-10} cm/sec.
- Prepared subbase with a minimum thickness of 2 feet and having a permeability less than or equal to 1.0×10^{-5} cm/sec.

Other requirements of this section include:

- A minimum slope of two percent (2%);
- Adequate foundation and prepared subgrade to support the liner and the landfilling activities; and,
- Maintain a minimum 3-foot separation between bedrock or the maximum expected groundwater elevation, whichever is higher, and the bottom of the liner system (subbase).

9.1.2 Proposed Liner System

The July 2020 version of the Phase III Application proposed the use of a Geosynthetic Clay Line (GCL) as part of an "Alternative Liner System". Pursuant to comments provided by the MDE on that version of the design, we have eliminated the proposed GCL and have modified the design to the COMAR specified 24-inch thick subbase with permeability less than or equal to 1.0×10^{-5} cm/sec.

We are still specifying the use of a geomembrane barrier layer (versus the 12-inch thick clay). Use of the gemembrane is specifically allowed under the regulations (COMAR Section 26.04.07.16 (C)(3)).

We are also still proposing that the leachate collection layer include a geocomposite drainage layer (GDL) and a 24-inch thick "highly permeable material". The GDL, though not specifically required in the COMAR regulation, supports satisfying the requirement to have a leachate collection systems to maintain head of no more than one foot (30 cm) atop the barrier layer of the liner. The GDL will work in conjunction with the two feet of natural materials, proposed to be locally mined sand, for leachate collection. Leachate collection and conveyance piping will be contained in the leachate collection layer, and will include perforated piping, in a stone envelope, wrapped in a nonwoven geotextile. Evaluation of the system for leachate collection and removal capabilities is addressed in Section 10 of this Report.

Based on the above, the proposed liner system for the Chesapeake Terrace Rubble Landfill includes the following, from top to bottom:

- Four feet of Select Waste (Waste material containing no long pipes, boards, or other materials that could damage the liner or leachate collection layer);
- 10 ounce per square yard (oz./s.y.) nonwoven geotextile for layer separation and visual indicator if breached;
- Two feet of leachate collection layer, comprised of locally mined sandy soils;
- A geocomposite drainage layer (GDL), consisting of a tri-planar drainage net with a minimum 8 oz./s.y. nonwoven geotextile heat-bonded to both sides;
- 60-mil high density polyethylene geomembrane with a permeability less than or equal to 1 x 10^{-10} cm/sec; and,
- Prepared subbase with a minimum thickness of 2 feet and having a permeability less than or equal to 1.0 x 10^{-5} cm/sec.

The landfill subgrade is in an excavated condition in most instances, with few locations requiring fill for constructing the cell floor subgrade. The perimeter berm for the landfill will be constructed of existing, excavated soils, and is supported by the perimeter drainage channels and perimeter access road. Minimum and maximum proposed grades of the landfill cell floors is two percent (2%) (post settlement) and thirty-three percent (33%), respectively. The subgrade will be prepared by proof-rolling after removal of any deleterious materials and observation of proof-rolling to confirm no pumping or rolling of the subgrade.

Information supporting the selection of the critical liner system components are as follows:

9.1.2.1 Leachate Collection Layer

The COMAR 26.04.07.16(C)-required leachate collection layer shall be covered with a minimum of 2 feet of sized gravel or other highly permeable material to provide for the free passage of leachate to the liner and to serve as a protective layer for the liner and leachate collection systems. The same regulations specify that the leachate collection must be constructed of materials that are a) chemically resistant to the waste managed in the landfill and the leachate expected to be generated; b) Of sufficient strength and thickness to prevent collapse or failure from loadings applied by overlying wastes, waste cover materials, and equipment used for landfilling operations; c) Designed and operated to function without clogging; d) Designed and operated to ensure that the depth of leachate over the liner does not exceed 30 centimeters (1 foot); and e) Designed to operate solely by the force of gravity in all areas where the system will directly underlie solid waste. The Site has significant amounts of sand that with little or no processing (i.e. screening) can meet the identified material requirements.

The leachate collection piping (headers and laterals) will be bedded in a stone envelope, with a nonwoven geotextile to "wrap" the stone and protect the underlying geosynthetic. The geotextile wrap also provides layer separation from the surrounding leachate collection materials.

9.1.2.2 Geocomposite Drainage Layer

Due to significant advances in GDLs, the permeability of the products is higher than can be achieved with a gravel or sand layer. The geocomposite drainage layer (GDL) works in conjunction with the leachate collection layer to quickly convey leachate from the cell floor to the leachate collection sump. A benefit of this quick action is the reduction of the maximum head that can buildup atop the barrier layer, which regulations limit to no more than 12 inches (30 cm).

9.1.2.3 Geomembrane

While COMAR allows the replacement of the 12-inch layer of clay with a 50 mil unreinforced geosynthetic, the Applicant recognizes that, at this time, a 60-mil thickness HDPE product is more readily available year-round, as it is more commonly specified and is continuously being manufactured. The 60-mil HDPE geomembrane is also commonly used for municipal solid waste (MSW) landfills, which have more stringent requirements than the rubble landfills. This product has been in use for municipal waste landfills for more than 30 years and has a long-established history of use as the barrier liner for the MSW landfills.

The permeability of the 60 mil HDPE geomembrane is 1 x 10^{-10} cm/sec – three orders of magnitude LOWER than the value specified in COMAR for this barrier layer. Further, the product is consistent over time and the installation is relatively straight-forward.

The construction of lower permeability natural soil barrier can prove problematic for consistency of material and source; may require importing a large volume of material, and can be problematic constructing on steeper slopes. These considerations make the geomembrane a superior product for this application.

9.1.2.4 Subbase

The subbase is the prepared surface upon which the liner system will be constructed, and the component that is intimate contact with the geomembrane that is intended to function as a secondary liner against vertical migration of liquids from the cell in the event the geomembrane layer (the primary liner) is compromised. The subbase will be at least 24-inches thick and have a permeability equal to or less than 1.0 x 10^{-5} cm/sec. This bottom of the subbase will be the excavated grades shown on Drawings 6 and 7., The bottom of the subbase will be the grades show on Drawings 10 and 11. The subgrade surface for the Subbase will be prepared by removal of any deleterious materials and proof-rolled to demonstrate a firm and unyielding subgrade. Details for subgrade preparation and Subbase construction are include in the Technical Specifications in Section 14 and the CQA Plan in Section 13.

9.1.3 Engineering Analysis

In order to select the material associated with this liner system, a series of engineering analyses were conducted, including the following:

- Liner anchor trench;
- Liner system veneer stability under various conditions;
- Puncture protection of the geomembrane liner;
- Subgrade bearing capacity; and,
- Settlement.

The following sections describe the evaluation of the liner system.

9.1.3.1 Liner Anchor Trench

The purpose of a liner system anchor trench is to hold the liner system geosynthetic components in-place during liner system construction and landfilling activities. The current approach recommended by Koerner, et al, is that the holding capacity of the anchor trench not exceed the maximum allowable yield stress of the geomembrane, as it is preferable for the geosynthetics to "pullout" of the anchor trench before the geosynthetic components yield and/or tear. Based on the analysis included in Attachment 9B, the anchor trench shall meet the following criteria:

- A minimum runout length of four feet (from the crest of the cell slope to the trench); and,
- A minimum trench depth of 2 feet.

9.1.3.2 Liner Puncture Protection

While the leachate collection layer (LCL) is proposed to include sandy soils, the LCL works in conjunction with the geocomposite drainage net during periods of higher leachate generation. Additionally, as indicated above, leachate conveyance piping will also be located in the LCL in a stone envelope wrapped in a nonwoven geotextile. The cell sump is the lowest point in each cell to which the leachate is directed. From this sump, leachate is pumped from the cell to a force main. In the cell sump, the sandy soils of the leachate collection layer are replaced with the same stone enveloping the leachate conveyance piping.

While geomembrane puncture is not anticipated to be an issue with the sandy soils comprising the LCL, the stone envelope around the leachate conveyance piping and in the cell sump are evaluated for puncture since the particle size is much larger. Koerner, et al, developed methods to evaluate the amount of protection required between the stone and the geomembrane to prevent puncture from occurring. The analysis considers the maximum stone diameter, the proposed maximum load, and the thickness of the nonwoven geotextile cushion, between the stone and geomembrane. The analysis is provided in Attachment 9C.

9.1.3.3 Liner Stability

The liner system must remain stable during construction and landfilling operations. The floor of the cell, with a relatively flat slope of 3% (min.), does not raise concern or merit evaluation. The liner system on the steeper (33%) slopes are the point of concern.

The method prescribed by Koerner evaluates the geosynthetics and the soils layers based on the interface friction angles of adjacent materials, and the wedge of soil comprising the leachate collection layer. While the interface friction angles used in the analyses are based on published data from manufacturers or Koerner, our analysis considered actual laboratory testing of the interface friction angles of materials selected for this project, based on another landfill project. This real laboratory testing data shows that the values included in our analysis are conservative.

The analysis was also evaluated for a variety of conditions including the following:

- Liner system in-place prior to landfilling occurring;
- Liner system placed on cohesive soils versus granular soil;
- Placement of the liner system leachate collection layer, with the bulldozer pushing the soils;
  - Up the slope; and,
  - Down the slope.
- Liner system with leachate buildup in the leachate collection layer;
  - 10% buildup;
  - 50% buildup; and,
  - 100% buildup.
- Seismic condition.

Some of these conditions did not satisfy minimum factors of safety. In particular, the placement of the LCL soils must occur by pushing the soils up the slope, not downslope. Thus, the specifications prohibit pushing the soils down the slope.

Also, a head build-up of more than 10% compromises the liner system on the steep slope. For this reason the geocomposite drainage layer has been included in the liner system. The evaluation of the geocomposite to perform as the LCL is described in Section 10.

Stability between the textured HDPE geomembrane and the Subbase soil layer is determined by the type of soil used for the subbase. A soil with lower soil HDPE-T interface friction angle (i.e. cohesive soils) will require placement of the leachate collection layer and the Select Waste layer as waste placement progresses to limit the difference in elevation between the waste surface and the highest point of the leachate collection layer to 12 feet. If a Subbase soil with and interface friction angle equal to or greater 24 degrees is utilized (and meets the permeability requirements), then the entire leachate collection layer and Select Waste can be constructed on any interior ell side slope.

The liner stability analysis is included in Attachment 9D.

9.1.3.4 Subgrade Bearing Capacity

Any discussion of bearing capacity invariably starts with a discussion of the work by Terzaghi and Peck. Terzaghi's bearing capacity formulae form the basis for nearly every treatise on foundation design and analysis. The initial application of Terzaghi's bearing capacity work was to the design of shallow foundations (strip or continuous, square, circular, etc.). It has become acceptable to apply Terzaghi's work to the bearing capacity of the subsoils beneath a landfill as one of the considerations needed in evaluating its stability.

The approach used in this analysis is that used by Szypcio and Dolzyk (2006). Szypcio and Dolzyk calculated bearing capacity of layered subsoils based on Terzaghi's formula, and treated the layered subsoil as a homogenous layer with average parameters. For this analysis, the average parameters are weighted averages based on soil layer thicknesses and the depth below the landfill that would be expected to influence bearing capacity. The applied bearing pressures due to the landfill were taken from the settlement analysis for this project (see Section 9.3 for discussion). To be conservative, this analysis considers the minimum factor of safety for bearing capacity to be three (3).

The locations evaluated were specifically selected as they represent the locations with the highest proposed loading due to the landfilling activities, to consider worst case scenarios. Under the scenarios evaluated, the actual factor of safety exceeded the minimum factor of safety of three. The detailed analysis is included in Attachment 9E.

9.1.3.5 Settlement

As a result of the proposed landfilling activities, the existing soils will be loaded with as much as 102 feet of rubble waste (includes select waste), plus the liner system subbase (2 feet), the leachate collection system (2 feet), and closure cap system (4 feet). The resulting loads could induce settlement of the landfill floor due to consolidation of the underlying soils. Settlement on the whole is not problematic if the entire area has the same new load added and the same subsurface conditions.

Differential settlement occurs when you have different loads imposed on foundations soils with differing geotechnical properties. For example, having a portion of a cell loaded with 150 feet of waste undergoing a settlement of 1.5 feet while another portion of the sell, near the sump, loaded with 20-feet of waste may only settle 0.3 feet. With a higher settlement at the upgradient end of a cell and the lower settlement at the downgradient end of a cell, the minimum slope of the cell may no longer meet the required two percent (2%) minimum after these differing settlement conditions are factored in. By estimating potential differential settlement of the cells floor prior to construction, the floor grades can be adjusted to provide a steeper initial construction, so that after differential settlement, a minimum floor slope of two percent is maintained.

Obviously, with the complex subsurface conditions described in great detail in the Phase II Report (Advanced GeoServices, June 2020) combined with the varying waste depth across the floor of the landfill, differential settlement analyses were performed for several proposed cells. The detailed calculations are provided in Attachment 9F. The conclusion of the analyses is that a minimum constructed slope of three percent (3%) will satisfy the minimum two percent (2%) slope after differential settlement.

9.1.3.6 Cell Grades Relative to High Water Table

COMAR 26.04.07.16 (C) (6) requires a "minimum vertical buffer distance between the bedrock elevation or the maximum expected groundwater elevation, whichever is higher, and the bottom of the liner system." Please refer to Section 4 of the Phase II Permit Application for further discussion of this item. As shown on Figure 4-1 in that Section, the minimum distances as measured at the bottom of the subbase layer beneath the sump and the top of the highest observed/highest predicted groundwater levels is equal to or greater than 3 feet.

9.2 Cap and Closure System

COMAR 26.04.07.21 requires the closure cap for rubble landfills to match the requirements for municipal landfills, by providing the following, from top to bottom:

- Earthen cover with a minimum thickness of 2 feet;
- Drainage layer with a minimum thickness of 6-inches and an in-place permeability of 1 x 10^{-3} cm/sec; and,
- A low permeability cap comprised of a synthetic material with a minimum thickness of 20 mils and a permeability less than or equal to 1 x 10^{-10} cm/sec or a 12-inch layer of soils with an in-place permeability of $1x10^{-5}$ cm/sec.

A 12-inch thick layer of intermediate cover is required in locations with no activity for more than 30 days, as part of normal operations. Prior to closure cap installation, a uniform final cover of 2 ft should be in place. The uniform final cover may be inclusive of the 12-inch thick layer of intermediate cover. The closure cap construction is expected to occur as areas of 6 or more acres have achieved maximum filling grades, to allow the operation to realize economies of scale with construction efforts. Thus, it is reasonable that all areas ready to receive the closure cap will have this layer of intermediate cover in-place by the time the closure cap construction commences.

Further, the closure cap must be constructed with a minimum slope of four percent (4%). Vegetative stabilization must be in-place within 30 days of the final earthen cover soils being installed.

Based on the foregoing, the closure cap for the Chesapeake Terrace Rubble Landfill will have the following components, from top to bottom:

- 6-inch thick layer of vegetative support layer (topsoil or other material capable of supporting vegetation);
- 18-inches of protective cover soils, with a permeability not exceeding $1x10^{-5}$ cm/sec;
- A geocomposite drainage layer, with a triplanar drainage net and 8 oz./s.y. nonwoven geotextile heat-bonded to both sides; and,
- 40-mil textured on both sides, linear low density polyethylene (LLDPE) geomembrane with a permeability less than or equal to 1 x 10^{-10} cm/sec.

While the regulations specify a 6-inch thick drainage layer, such a thin layer of soil cannot be safely placed atop a geomembrane without risking puncture or damage from the construction equipment placing the soils. Further, a geocomposite drainage layer can provide a much higher permeability, on the order of two or three orders of magnitude higher compared to a permeability of 0.001 cm/sec for naturally occurring sandy soils. The cover soil can then be deployed in one 18-inch thick layer atop the geocomposite drainage layer, using low-ground pressure equipment, and maintaining a minimum of 12 inches of soil between the tracks of the equipment and the geosynthetic components.

To support the selection of the closure system and the properties of the materials, a series of analyses were conducted as follows:

- Veneer Stability;

- Isolated Settlement; and,
- Drainage Layer permeability

The sections below provide a summary of each of these analyses.

9.2.1 Closure Cap Veneer Stability

The closure cap system must remain stable during construction and the closure/post-closure period. The crown of the landfill, with slopes of at least 4%, does not raise concern or merit evaluation. The closure cap system on the steeper (25%) slopes are the point of concern.

The method prescribed by Koerner evaluates the geosynthetics and the soils layers for the liner system stability, described in Section 9.1.3, is the same method used to evaluate the closure cap veneer stability. While the interface friction angles used in the analyses are based on published data from manufacturers or Koerner, our analysis considered actual laboratory testing of the interface friction angles of materials selected for this project, based on another landfill project. This real laboratory testing data shows that the values includes in our analysis are conservative (i.e., lower than real conditions).

Similar to the liner system stability analysis, the analysis was also evaluated for a variety of conditions including the following:

- Closure cap system in-place after construction;
- Placement of the cover soil, with the bulldozer pushing the soils;
    - Up the slope; and,
    - Down the slope.
- Closure system with leachate buildup in the leachate collection layer;
    - 10% buildup;
    - 50% buildup; and,
    - 100% buildup.
- Seismic Condition.

Some of these conditions did not satisfy minimum factors of safety. In particular, the placement of the soils must occur by pushing the soils upslope, not downslope. Thus, the specifications prohibit pushing the soils down the slope.

Also, a head building of more than 10% compromises the closure cap system on the steep slope. For this reason the geocomposite drainage layer has been included in the closure cap system in lieu of a 6-inch thick layer of higher permeability soils and the cover soils have a permeability requirement. The evaluation of the geocomposite to perform as the closure cap drainage layer is described in Section 9.2.3.

The closure cap stability analysis is included in Attachment 9H.

9.2.2 Isolated Settlement

The closure cap system will experience some settlement due to waste consolidation. Due to the nature of the waste, some decomposition is expected to occur. With most materials not undergoing decomposition, it is possible that there may be isolated locations of settlement, where a low-spot or small depression may develop.

The concern for having isolated settlement areas is two-fold: (1) the potential for water to pond and saturate that area of the cap, and (2) maintaining the integrity of the geomembrane component of the cap. If this occurs on the steep slopes, this will be a non-issue relative to reducing the potential for ponding. The more critical locations are on the flatter slopes.

The isolated, or localized, settlement analysis indicates that the geomembrane in the closure system can withstand differing isolated settlement, depending on the geometry. The analysis includes a table that the operator can use to evaluate a variety of field measurements to discern whether a more robust repair is required or whether some regrading of the area is an acceptable solution.

The isolated settlement analysis is provided in Attachment 9I.

9.2.3 Closure Cap Drainage Layer

As indicated previously, the placement of a 6-inch thick cap drainage layer immediately atop the geomembrane component of the closure cap system is a constructability issue on flatter slopes, and even more challenging on steeper slopes. This is challenging because the tracks of a bulldozer typically have a 5-inch relief, and the blade of the bulldozer used to push the soil up the slope could readily puncture or nick the geomembrane without being observed or noticed.

To avoid this risk altogether, a geocomposite drainage layer is proposed for use as the closure cap drainage layer. A triplanar drainage net with an 8 oz./s.y. nonwoven geotextile heat bonded to both sides is proposed. To evaluate the adequacy of this product, methods outlined by Richardson, et al, were used. The methods rely heavily on Darcy's equation relative to transmission of water through the geocomposite drainage layer and the permeability of the overlying soil layer, assuming that the layer can convey all water passing through the overlying cover soil layer minimizing head buildup atop the geomembrane.

This condition was evaluated for the steep slopes between the stormwater terraces, where this drainage layer will be daylighted, and for the shallow slopes where longer drainage lengths could cause head buildup. For conservatism, the analysis considers the flow from the shallow crown area remains in the geocomposite drainage net on the steep slope above the upper-most terrace.

The analysis, included in Attachment 9J, shows that a readily-available triplanar geocomposite drainage net product will perform adequately for both minimum and maximum slope conditions, as long as the cover soils have a permeability less than or equal to 1×10^{-5} cm/sec.

9.3 Global Stability

A slope stability analysis was performed to evaluate the factor of safety under static seismic conditions. Circular and non-circular slip surfaces were evaluated using the software Slope/W module of the GeoStudio by GEO-SLOPE International, Ltd., (copyright 2004-2017). The Spencer and Bishop methods were utilized.

Cells 10, 5D, 13 and 16 were the focus of the computer analysis. Cells 5D and 16 were included since they align with Cells 10 and 13, respectively, along the cell long axis. Subsoil profiles were taken from the settlement and bearing analyses. Additional information was added to represent subsoil conditions in Cells 5D and 16.

From USGS information, the maximum horizontal acceleration for the site area is 0.065g. USEPA seismic design guidance suggests the use of 50% of this value for design based on work by Hynes and Franklin (1984). A value of 0.0325 was used as the coefficient of horizontal acceleration, Kh.

<u>Circular Slip Surfaces</u>: Factors of safety of at least 1.6 were calculated for the pseudo-static condition by both the Bishop and Spencer Methods. It is noted that in all cases, the minimum factor of safety was associated with a very shallow veneer slip surface within the cap system. Other potential slip surfaces evaluated extended into the waste, and others also extended through the waste and into the underlying subsoils. These slip surfaces all had higher factors of safety.

When the horizontal seismic coefficient, Kh, of 0.0325 was added, the minimum factor of safety was reduced to 1.4. Again, this was associated with a very shallow veneer slip within the cap system.

Detailed information is included in Attachment 9J.

<u>Non-Circular Slip Surfaces</u>: A minimum factor of safety of 1.7 was calculated by the Bishop Method. This was associated with a shallow veneer slip surface. Slip surfaces that extended into the waste or deeper were associated with factors of safety of at least 2.6. Other potential slip surfaces evaluated extended into the waste, and others also extended through the waste and into the underlying subsoils. These slip surfaces all had higher factors of safety.

When the horizontal seismic coefficient, Kh, of 0.0325 was added, the minimum factor of safety was reduced to 1.4. Again, this was associated with a very shallow veneer slip within the cap system.

Detailed information is included in Attachment 9J.

<u>Sliding Wedge Analysis</u>: A sliding wedge analysis was performed for Cells 10, 5D, 13, and 11. Cell 16 was not included since it was believed the overall geometry of Cell 16 would render acceptable results compared to the other cells analyzed. Cell 11, however, is the only cell to have the potential slip surface (GCL to underlying subsoil) located on all three general areas of the cell – the sideslope at the sump, the floor, and the sideslope on the upgradient end of the cell.

For this analysis, each cell has three “blocks”. The mass on the floor of the cell is called the “central block”. Upgradient, the mass is called the “active block. The sliding surface of this block is defined by either the presence of the specific interface of concern, or a projected active wedge slip based on earth pressure theory.

Down gradient of the central block, the mass on the sideslope is called the “passive block”. It is defined as a sliding wedge because the specific interface of concern is present.

The horizontal seismic force is added by multiplying the horizontal factor by the weight of each block, and using that as an additional force in the horizontal direction. This force is presumed to act towards the downslope direction.

Based on this analysis, the following tables summarize the factors of safety calculated.

Factors of Safety Sliding Wedge Slip Surface, Static		
Cell	**Static Factor of Safety**	**Dynamic Factor of Safety**
1. Cell 13	13.8	6.3
2. Cell 11	3.9	1.6
3. Cell 5D	4.8	3.3
4. Cell 10	12.3	6.0

Detailed information is included in Attachment 9J.

ATTACHMENT 9A

NOT USED

ATTACHMENT 9B

Liner Anchor Trench

ADVANCED GeoServices a Montrose Environmental Group company	**Subject:** Liner Anchorage		
	Job No. 2018-3854	**Made by:** JCA	**Date** 06/19/20
	Ref.	**Checked by:** VEF	**Sheet** 1 **of** 1

Reviewed by PGS 08/26/2021

Objective:

Design the liner anchorage to hold the geosynthetics against applied loads.

Design Approach and Assumptions:

1. The anchorage system includes a flat runout length at the top of the slope with a short drop into a trench. The trench is backfilled with compacted soil.
2. The layer of drainage sand terminates at the top of the landfill sideslopes, and does not extend into the anchorage system.
3. The holding capacity of the anchorage system is developed by the combination of the vertical load of the cover soils placed on top of the runout length, and the lateral load from the anchor trench backfill.
4. Interface friction values vary based on the materials as layered. For design purposes, the lowest interface friction value between layers is used. (References 2 and 5)
5. An imaginary frictionless pulley is positioned at the crest of the anchor trench, allowing the frictional forces to be summed along the plane of the geosynthetic layers. (Reference 1)
6. It is preferred to design the anchorage system such that the geosynthetic layers pull out before the geomembrane yields. Consequently, a factor of safety against yield of 1.5 is used.

Calculation:

From the attached calculation sheet, the proposed anchorage configuration that includes a 4-ft runout length, and 2-ft deep anchor trench, would have a capacity of approximately 861 lb. (presuming a unit 1-ft width of layered geosynthetics). Applying a factor of safety of 1.5 to the textured HDPE geomembrane (HDPE-T) yield stress of 1,512 lb. (Reference 3), a maximum allowable capacity of the anchorage system would be 1,008 lb.

Conclusion:

Since the anchorage system capacity is less than the maximum allowable capacity, the anchorage system should pullout before the HDPE-T yields.

References:

1. Qian, X., Koerner, R.M., Gray, D.H., (2002). *"Geotechnical Aspects of Landfill Design and Construction"*; Prentice Hall; Upper Saddle River, NJ; 1st Ed., Sect. 4.7.2.
2. Koerner, G., and Narejo,D.; Geosynthetic Research Institute; GRI Report #30- *"Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"*; 2005.
3. Manufacturer's data, various.
4. Site specific data, estimated.
5. Calculation to estimate interface friction between GDN w/GT-NW to Cohesive Soil.

Project:
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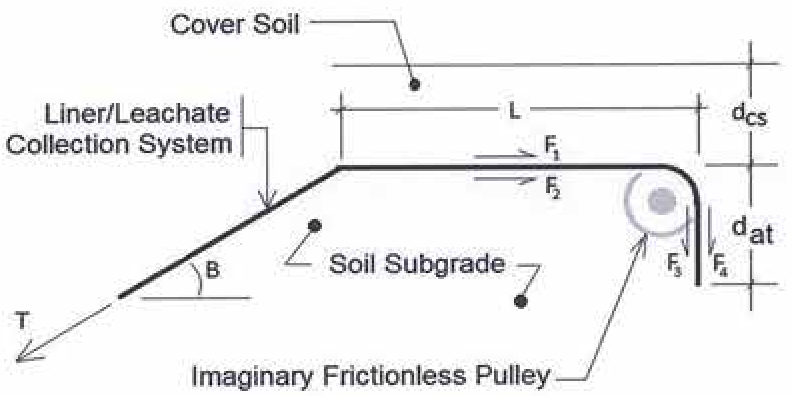
Checked: VEF **Date:** 07/15/20
Subject: Liner Anchorage

Geomembrane Anchor Trench Design

Reviewed by PGS 08/26/2021

Description
Design of the Geomembrane Anchor Trench



(Reference 1)

General Data

Slope horizontal, H = 3.0
Slope Vertical, V = 1
Slope Angle, B = 18.4 deg

Cover Soil and Prepared Subgrade

Depth of cover soil, d_{cs} = 2.0 ft
Density of cover soil, γ_{cs} = 115.0 pcf
Length of anchor runout, L = 4.0 ft
Cover soil pressure on GM-T, q_B= 230.0 psf

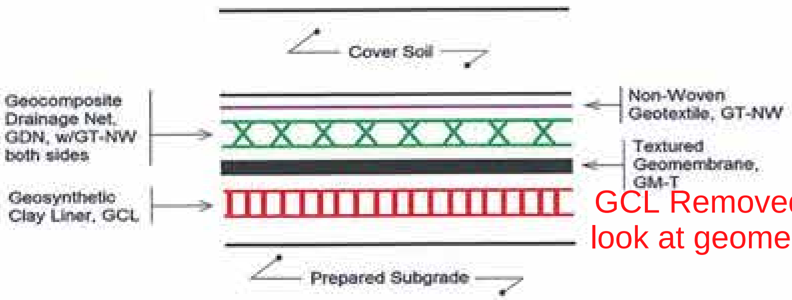
Anchor Trench

Depth of anchor trench, d_{at} = 2.0 ft
Average depth of anchor trench, $d_{avg} = (d_{at}/2)$ = 1.0 ft
Density of anchor trench backfill soil, γ_{at} = 115.0 pcf
Anchor trench backfill soil internal friction angle, ϕ_{at} = 28.0 deg
Anchor trench backfill soil coef of earth pressure at rest, Ko-at = 0.53

Average vertical pressure in anchor trench, $\sigma_{v\text{-}avg}$

$\sigma_{v\text{-}avg} = (\gamma_{cs})(d_{cs}) + (\gamma_{at})(d_{avg})$ = 345.0 psf

Geosynthetics



GCL Removed from Design
look at geomembrane to subbase

ADVANCED GeoServices
a Montrose Environmental Group company

Project:
P.N.: 2018-3854 **Page:** 2 of 2
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Checked: VEF VEF **Date:** 07/15/20
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Reviewed by PGS 08/26/2021

Geosynthetics Data (Reference 3)

Non-woven Geotextile, GT-NW = 10 oz/sf
Textured Geomembrane, GM-T = HDPE-T 60 mil
Textured Geomembrane Yield Stress, T_y = 1,512 lb/ft
Geosynthetic Clay Liner, GCL = Bentonite w/2 layers of Non-Woven Needle Punched Geotextile (NW-NP-GT).

Estimated Interface Friction Angles (References 2 and 5)

GT-NW to GDN w/GT-NW, δ_4 = 27 deg
GDN w/GT-NW to GM-T, δ_7 = 26 deg
δ_{des} = 16
GCL Removed from Design ----------~~GM-T to GCL,~~-- δ_8 = -~~23~~-- deg ~~23.0~~ deg
GM-T to Granular Subbase ~~GCL to prepared Granular subgrade,~~ δ_9 8 = --~~27~~- deg 31
GM-T to Granular Subbase ~~GCL to prepared Cohesive subgrade,~~ δ_9 8 = -~~24.5~~ deg 16(saturated)

Anchor Trench Capacity and Factors of Safety (Reference 1)

Geomembrane anchor trench capacity, T

$$T = \frac{(q_B)(L)(\tan \delta_{des}) + 2(K_{o\text{-}at})(\sigma_{v\text{-}avg})(d_{at})(\tan \delta_{des})}{\cos B - (\sin B)(\tan \delta_{des})}$$

T = --~~861~~552 lb/ft
Minimum Factor of Safety Against T_y, MFS = 1.5
Allowable stress in the geomembrane, $T_{all} = (T_y)/(MFS)$ = 1,008 lb/ft

Results still OK

Since T < Tall, the anchor trench should pull out before the HDPE-T yields.

References:

1 Qian, X., Koerner, R.M., Gray, D.H., (2002). "Geotechnical Aspects of Landfill Design and Construction"; Prentice Hall; Upper Saddle River, NJ; 1st Ed., Sect. 4.7.2.

2 Koerner, G., and Narejo,D.; Geosynthetic Research Institute; GRI Report #30- "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"; 2005.

3 Manufacturer's data, various.
4 Site specific data, estimated.
5 Calculation to estimate interface friction between GDN w/GT-NW to Cohesive Soil.

δ ↓

Appendix Table 1. Summary of interface shear strengths.

terface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
DPE-S	Granular Soil	1a	21	0	162	0.93	1b	17	0	128	0.92
DPE-S	Cohesive Soil										
	Saturated	1c	11	7	79	0.94	1d	11	0	59	0.95
	Unsaturated	1c	22	0	44	0.93	1d	18	0	32	0.93
DPE-S	NW-NP GT	1e	11	0	149	0.93	1f	9	0	82	0.96
DPE-S	Geonet	1g	11	0	196	0.90	1h	9	0	118	0.93
DPE-S	Geocomposite	1i	15	0	36	0.97	1j	12	0	30	0.93
DPE-T	Granular Soil	2a	34	0	251	0.98	2b	31*	0	239	0.96
DPE-T	Cohesive Soil										
	Saturated	2c	18	10	167	0.93	2d	16 *	0	150	0.90
	Unsaturated	2c	19	23	62	0.91	2d	22	0	35	0.93
DPE-T	NW-NP GT	2e	25	8	254	0.96	2f	17	0	217	0.95
DPE-T	Geonet	2g	13	0	31	0.99	2h	10	0	27	0.99
DPE-T 7	Geocomposite	2i	26*	0	168	0.95	2j	15	0	164	0.94
LDPE-S	Granular Soil	3a	27	0	6	1.00	3b	24	0	9	1.00
LDPE-S	Cohesive Soil	3c	11	12.4	12	0.94	3d	12	3.7	9	0.93
LDPE-S	NW-NP GT	3e	10	0	23	0.63	3f	9	0	23	0.49
LDPE-S	Geonet	3g	11	0	9	0.99	3h	10	0	9	1.00
LDPE-T 3	Granular Soil	4a	26*	7.7	12	0.95	4b	25	5.2	12	0.95
LDPE-T	Cohesive Soil	4c	21	5.8	12	1.00	4d	13	7.0	9	0.98
LDPE-T 2	NW-NP GT	4e	26*	8.1	9	1.00	4f	17	9.5	9	0.96
LDPE-T	Geonet	4g	15	3.6	6	0.97	4h	11	0	6	0.98
VC-S	Granular Soil	5a	26	0.4	6	0.99	5b	19	0	6	0.99
VC-S	Cohesive Soil	5c	22	0.9	11	0.88	5d	15	0	9	0.95
VC-S	NW-NP GT	5e	20	0	89	0.91	5f	16	0	83	0.74
VC-S	NW-HB GT	5g	18	0	3	1.00	5h	12	0.1	3	1.00
VC-S	Woven GT	5i	17	0	6	0.54	5j	7	0	6	0.93
VC-S	Geonet	5k	18	0.1	3	1.00	5l	16	0.6	3	1.00

REFERENCE 2 Pg 2/2

Appendix Table 1. (continued)

δ

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
PVC-F	NW-NP GT	6a	27	0.2	26	0.95	6b	23	0	26	0.95
PVC-F	NW-HB GT	6c	30	0	8	0.97	6d	27	0	8	0.90
PVC-F	Woven GT	6e	15	0	6	0.78	6f	10	0	6	0.76
PVC-F	Geonet	6g	25	0	11	1.00	6h	19	0	11	0.99
PVC-F	Geocomposite	6i	27	1.1	5	1.00	6j	22	4.7	6	1.00
CSPE-R	Granular Soil	7a	36	0	3	1.00	7b	16	0	3	1.00
CSPE-R	Cohesive Soil	7c	31	5.7	6	0.71	7d	18	0	6	0.99
CSPE-R	NW-NP GT	7e	14	0	6	0.97	7f	10	0	6	0.98
CSPE-R	NW-HB GT	7g	21	0	3	1.00	7h	10	0	3	1.00
CSPE-R	Woven GT	7i	11	0	6	0.92	7j	11	0	3	1.00
CSPE-R	Geonet	7k	28	0	9	0.87	7l	16	0	9	0.80
NW-NP GT	Granular Soil	8a	33	0	290	0.97	8b	33	0	117	0.96
NW-HB GT	Granular Soil	8c	28	0	6	0.99	8d	16	0	6	0.91
Woven GT	Granular Soil	8e	32	0	81	0.99	8f	29	0	28	0.98
NW-NP GT	Cohesive Soil	9a	30	5	79	0.96	9b	21	0	28	0.79
NW-HB GT	Cohesive Soil	9c	29	0.9	15	0.71	9d	10	0	15	0.83
Woven GT	Cohesive Soil	9e	29	0	34	0.94	9f	19	0	16	0.86
GCL Reinforced (internal)	N/A	10a	16	38	406	0.85	10b	6	12	182	0.91
GCL (NW-NP GT) 8	HDPE-T	11a	23 *	8	180	0.95	11b	13	0	157	0.90
GCL (W-SF GT)	HDPE-T	11c	18	11	196	0.96	11d	12	0	153	0.92
Geonet	NW-NP GT	12a	23	0	52	0.97	12b	16	0	32	0.97
Geocomposite 1,4,5, (NW-NP GT) 6,9	Granular Soil	13a	27 *	14	14	0.86	13b	21	8	10	0.92

REFERENCE 3

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PRODUCT DATA SHEET

GSE HD Textured Geomembrane

GSE HD Textured is a co-extruded textured high density polyethylene (HDPE) geomembrane available on one or both sides. It is manufactured from the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased frictional resistance, excellent chemical resistance and endurance properties.

[*]

AT THE CORE:
An HDPE geomembrane used in applications that require increased frictional resistance, excellent chemical resistance and endurance properties.

Product Specifications

These product specifications meet GRI GM13

Tested Property	Test Method	Frequency	Minimum Average Value				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	30 27	40 36	60 54	80 72	100 90
Density, g/cm³	ASTM D 1505	200,000 lb	0.940	0.940	0.940	0.940	0.940
Tensile Properties (each direction Strength at Break, lb/in-width Strength at Yield, lb/in-width Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in G.L. 1.3 in	20,000 lb	 45 63 100 12	 60 84 100 12	 90 126 * 100 12	 120 168 100 12	 150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lb	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lb	45	60	90	120	150
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Asperity Height, mil	ASTM D 7466	second roll	16	18	18	18	18
Notched Constant Tensile Load(2), hr	ASTM D 5397, Appendix	200,000 lb	500	500	500	500	500
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>100	>100	>100	>100	>100
TYPICAL ROLL DIMENSIONS							
Roll Length(3), ft	Double-Sided Textured Single-Sided Textured		830 1,010	700 780	520 540	400 410	330 330
Roll Width(3), ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft²	Double-Sided Textured Single-Sided Textured		18,675 22,725	15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:

- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)NCTL for GSE HD Textured is conducted on representative smooth membrane samples.
- (3)Roll lengths and widths have a tolerance of ±1%.
- GSE HD Textured is available in rolls weighing approximately 4,000 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

$* \; (126 \text{ lb/in})(12 \text{ in/ft}) = 1512 \text{ lb/ft}$

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

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REFERENCE 5 Pg 1/1

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Ref: "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"; GRI Report #30; June 14, 2005.

Geocomposite (NW-NP-GT) to granular soil $\delta = 27°$

NW-NP-GT to granular soil $\delta = 33°$

$$\text{ratio} = \frac{27°}{33°} = 0.818$$

NW-NP-GT to cohesive soil $\delta = 30°$

For Geocomposite (NW-NP-GT) to cohesive soil, use:

$$\delta_g = (0.818)(30°) = 24.5°$$

SHEET 1 OF 1 PROJECT NO. ____ PROJECT NAME Chesapeake Terrace Landfill

BY JCA DATE 10/21/19 DESCRIPTION Est. δ for geocomposite-to-cohesive soil interface

CHK. BY ____ DATE ____

ATTACHMENT 9C

Liner Puncture Protection

Reviewed by PGS 08/26/2021

Objective:

The objective of this analysis is to determine the factor of safety against the puncture of the geomembrane liner by large diameter stones used in the leachate collection system. Puncture protection is provided by one or more layers of nonwoven, needle-punched geotextile.

Design Approach:

This analysis is based on Dr. Robert Koerner's work as published in References 1 and 2, and as slightly modified by Reference 7. The general design steps for this analysis are as follows:

1. Determine the point of greatest waste depth. At this point, estimate the maximum expected vertical pressure (MEP) due to the various layers and thicknesses of leachate collection system, waste, and cap system.
2. Based on the maximum diameter of the coarse aggregate bedding for the leachate collection piping, estimate the protrusion height of the stone against the geomembrane liner.
3. Based on various design parameters, select modification factors and reduction factors to be used in calculating the maximum allowable pressure on the geotextile.

In August 2013, the author of this analysis corresponded with Dr. Robert Koerner, and inquired about the change to the maximum allowable pressure design equation as compared between Reference 1 (1996), and his 6th edition of *"Designing with Geosynthetics"* (2012), which is identical on this subject to that in Reference 2, (2008). Note the following figures:

$$P'_{all} = \left(450\left(\frac{M}{H^2}\right)\right)\left(\frac{1}{MF_s \times MF_{pd} \times MF_a}\right)\left(\frac{1}{RF_{cbd} \times RF_{cr}}\right) \geq 50$$

Reference 1 (H has units "mm").

$$P'_{all} = \left(50 + 0.00045\left(\frac{M}{H^2}\right)\right)\left(\frac{1}{MF_s \times MF_{pd} \times MF_a}\right)\left(\frac{1}{RF_{cbd} \times RF_{cr}}\right)$$

Reference 2 (H has units "m").

Dr. Koerner indicated the "50 +" was added to the Reference 2 equation to allow the use of the puncture resistance provided by a 60-mil HDPE geomembrane. It is concluded that removing the "50 +" term from the Reference 2 equation would be conservative. Therefore, this analysis subsequently uses the following equation from Reference 2, as modified:

Reviewed by PGS 08/26/2021

$$P'_{all} = \left(0.00045\left(\frac{M}{H^2}\right)\right)\left(\frac{1}{MF_s \times MF_{pd} \times MF_a}\right)\left(\frac{1}{RF_{cbd} \times RF_{cr}}\right)$$

Reference 2 (H has units "m"), as modified.

4. Calculate a factor of safety defined as FS = (P'_{all} / MEP), and compare this to a minimum FS of 1.5.
5. Repeat this analysis for the greatest waste thickness over a leachate collection pipe.

Calculation:

For the greatest waste depth over the geomembrane liner, a FS against puncture for the given conditions described was calculated to be 3.0. For the greatest waste depth over a leachate collection sump, a FS against puncture for the given conditions described was calculated to be 3.4. Detailed calculations are attached.

Conclusion:

Based on the foregoing, the proposed design provides a FS of at least 3.0 against puncture of the geomembrane liner against the large diameter aggregate to be used in the leachate collection system.

References:

1. Wilson-Fahmy, Ragui, and Koerner, Robert M., et al, *"A Design Methodology for the Puncture Protection Design of Geomembranes"*; GRI Report #13; Geosynthetics Research Institute, Drexel University; September 26, 1994
2. Koerner, Robert M., *"Modification to the "GRI Method" for the RFCR Factor Used in the Design of Geotextiles for Puncture Protection of Geomembranes"*, GRI White Paper #14; Geosynthetic Institute; Nov 24, 2008.
3. General project design.
4. Leachate Collection Pipe Detail (not used for sump calculation).
5. Maryland Department of Transportation, State Highway Administration, *"Standard Specifications for Construction and Materials"*, July 2018, Table 901 A.
6. Leachate Sump Detail (not used for floor calculation).
7. Personal correspondence with Dr. Robert Koerner.

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2021 Phase 3 Design Revision

Project:
P.N.: 2018-3854 **Page:** 1 of 1
By: JCA **Date:** 07/15/20
Checked: VEF **Date:** 07/15/20
Subject: Liner Puncture Protection - Floor

Reviewed by PGS 08/26/2021

Liner Puncture Protection

Description

Determine the minimum weight of a non-woven geotextile needed for puncture protection for the geomembrane liner based on the greatest thickness of waste across the floor of the landfill.

Include 24" Subbase at 125 pcf = 250 psf

General Data

Cap Layer Thickness = ~~3.0~~ ft 4.0 ft=460 psf
Cap Layer Density = 115 pcf
Waste Layer Thickness = ~~144.0~~ ft use 120.0 max=5,844 psf
Waste Density = 48.7 pcf
Select Waste ~~Leachate Collection~~ Layer Thickness = 4.0 ft
Leachate Collection Layer Density = 115 pcf
Leachate Collection Stone Thickness = 2.0 ft
Leachate Collection Stone Density = 125 pcf
Maximum Expected Pressure, MEP = 7,264 ~~8,068~~ psf = ~~386~~ 348 kPa
Stone Designation = #57
Maximum Stone Diameter, MSD = 1.50 in = 0.0381 m
Estimated Protrusion, H = 0.5 x MSD 0.0191 m
Geotextile Weight, M = 1,151 g/m^2 = 34.0 oz/sy

Modification and Reduction Factors *(Reference 2)*

Shape; MFs = 1.00
Packing Density, MFpd = 0.83
Soil Arching, MFa = 0.75
Chemical/Biological Degradation, RFcbd = 1.50
Creep, RFcr = 1.30
Product of Modification and Reduction Factors, PMRF = 1.21

Design Equations *(References 1 and 2)*

$$P'_{all} = \left(0.00045\left(\frac{M}{H^2}\right)\right)\left(\frac{1}{MF_s \times MF_{pd} \times MF_a}\right)\left(\frac{1}{RF_{cbd} \times RF_{cr}}\right)$$

Reference 2 (H has units "m"), as modified.

Design Allowable Pressure, P'all = 1,175.8 kPa

Global Factor of Safey, FS (P'all)/(MEP) = ~~3.0~~ 3.4

Minimum Global Factor of Safety, FS = 3.0 (Reference 1)

References:

1 *Wilson-Fahmy, Ragui, and Koerner, Robert M., et al, "A Design Methodology for the Puncture Protection Design of Geomembranes"; GRI Report #13; Geosynthetics Research Institute, Drexel University; Sept 26, 1994.*
2 *Koerner, Robert M., "Modification to the "GRI Method" for the RF_{CR} Factor Used in the Design of Geotextiles for Puncture Protection of Geomembranes", GRI White Paper #14; Geosynthetic Institute; Nov 24, 2008.*
3 *General project design.*
4 *Leachate Collection Pipe Detail.*
5 *Maryland Department of Transportation, State Highway Administration, "Standard Specifications for Construction and Materials", July 2018, Table 901 A.*
6 *Leachate Sump Detail (not used for floor calculation).*
7 *Personal correspondence with Dr. Robert Koerner.*

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Project: 2021 Phase 3 Design Revision
P.N.: 2018-3854 **Page:** 1 of 1
By: JCA **Date:** 07/15/20
Checked: VEF VEF **Date:** 07/15/20
Subject: Liner Puncture Protection - Sump
Reviewed by PGS 08/26/2021

Liner Puncture Protection

Description

Determine the minimum weight of a non-woven geotextile needed for puncture protection for the geomembrane liner based on the deepest sump in the landfill.

General Data

Cap Layer Thickness = ~~3.0~~ ft 4.0 ft=460 psf
Cap Layer Density = 115 pcf
Waste Layer Thickness = ~~122.0~~ ft use 120.0 max =5,844 psf
Waste Density = 48.7 pcf
Select Waste ~~*Leachate Collection*~~ *Layer Thickness* = 4.0 ft
Leachate Collection Layer Density = 115 pcf
Leachate Collection Stone Thickness = 3.0 ft
Leachate Collection Stone Density = 125 pcf
Maximum Expected Pressure, MEP = 7,139 ~~7,121~~ psf = ~~341~~ 342kPa kPa
Stone Designation = #57
Maximum Stone Diameter, MSD = 1.50 in = 0.0381 m
Estimated Protrusion, H = 0.5 x MSD 0.0191 m
Geotextile Weight, M = 1,151 g/m^2 = 34.0 oz/sy

Modification and Reduction Factors (Reference 2)

Shape; MFs = 1.00
Packing Density, MFpd = 0.83
Soil Arching, MFa = 0.75
Chemical/Biological Degradation, RFcbd = 1.50
Creep, RFcr = 1.30
Product of Modification and Reduction Factors, PMRF = 1.21

Design Equations (References 1 and 2)

$$P'_{all} = \left(0.00045\left(\frac{M}{H^2}\right)\right)\left(\frac{1}{MF_s \times MF_{pd} \times MF_a}\right)\left(\frac{1}{RF_{cbd} \times RF_{cr}}\right)$$

Reference 2 (H has units "m"), as modified.

Design Allowable Pressure, P'all = 1,175.8 kPa

Global Factor of Safey, FS (P'all)/(MEP) = ~~3.4~~ 3.4

Minimum Global Factor of Safety, FS = 3.0 (Reference 1)

References:
1. *Wilson-Fahmy, Ragui, and Koerner, Robert M., et al, "A Design Methodology for the Puncture Protection Design of Geomembranes"; GRI Report #13; Geosynthetics Research Institute, Drexel University; Sept 26, 1994.*
2. *Koerner, Robert M., "Modification to the "GRI Method" for the RF $_{CR}$ Factor Used in the Design of Geotextiles for Puncture Protection of Geomembranes", GRI White Paper #14; Geosynthetic Institute; Nov 24, 2008.*
3. *General project design.*
4. *Leachate Collection Pipe Detail (not used for sump calculation).*
5. *Maryland Department of Transportation, State Highway Administration, "Standard Specifications for Construction and Materials", July 2018, Table 901 A.*
6. *Leachate Sump Detail.*
7. *Personal correspondence with Dr. Robert Koerner.*

REFERENCE 2

Pg 1/2

Table 1. Modification factors and reduction factors for geotextile protection material design using Equation 2, i.e., the "GRI-Method".

(a) Modification factors (all ≤ 1.0)

MF_s		MF_{PD}		MF_A	
Angular	1.0 ✓	Isolated	1.0	Hydrostatic	1.0
Subrounded	0.5	Dense, 38 mm	0.83 ✓	Geostatic, shallow	0.75 ✓
Rounded	0.25	Dense, 25 mm	0.67	Geostatic, mod.	0.50
		Dense, 12 mm	0.50	Geostatic, deep	0.25

(b) Reduction factors (all ≥ 1.0)

		RF_{CR}			
		~~Mass per unit area~~	~~Protrusion height (mm)~~		
RF_{CBD}		~~(gm/m^2)~~	~~38~~	~~25~~	~~12~~
Mild leachate	1.1	~~Geomembrane alone~~	~~N/R~~	~~N/R~~	~~N/R~~
Moderate leachate	1.3	~~270~~	~~N/R~~	~~N/R~~	~~>1.5~~
Harsh leachate	1.5 ✓	~~550~~	~~N/R~~	~~1.5~~	~~1.3~~
		~~1100~~	~~1.3~~	~~1.2~~	~~1.1~~
		~~>1100~~	~~≅ 1.2~~	~~≅ 1.1~~	~~≅ 1.0~~

Abbreviation: N/R = Not recommended

The design situation can be approached by using a given mass per unit area geotextile to determine the unknown FS-value, or from using a given FS-value to determine the unknown mass per unit area geotextile. Koerner (2005) gives numeric examples, and Valero and Austin (1999) present design charts for the many variables contained in the design equation. It might be noted that this method is the only design method that allows for direct selection of a geotextile protection material without the need for large scale trail-and-error experimental testing.

In Equation 2 the two terms "RF_{CBD}" and "RF_{CR}" are intended to extend the short term test results into a simulated long term performance behavior. Since HDPE is quite resistant to chemical and biological degradation, the term RF_{CBD} is comparatively small. The term RF_{CR}, however, is not small and in many cases a "not recommended" decision is suggested. Due to its importance in the overall design, a series of long term creep tests using this same methodology,

REFERENCE 2
pg 2/2

Table 3. Revised values for "RF_{CR}" to be used in Equation 2 for geotextile protection materials design.

Mass per unit area (g/m^2)	"RF_{CR}"-Values Protrusion Height (mm)		
	38✓	25	12
Geomembrane alone	N/R	N/R	N/R
270	N/R	N/R	N/R
550	N/R	N/R	>1.5
1100	N/R	1.5	1.3
>1100	1.3✓	1.2	1.1

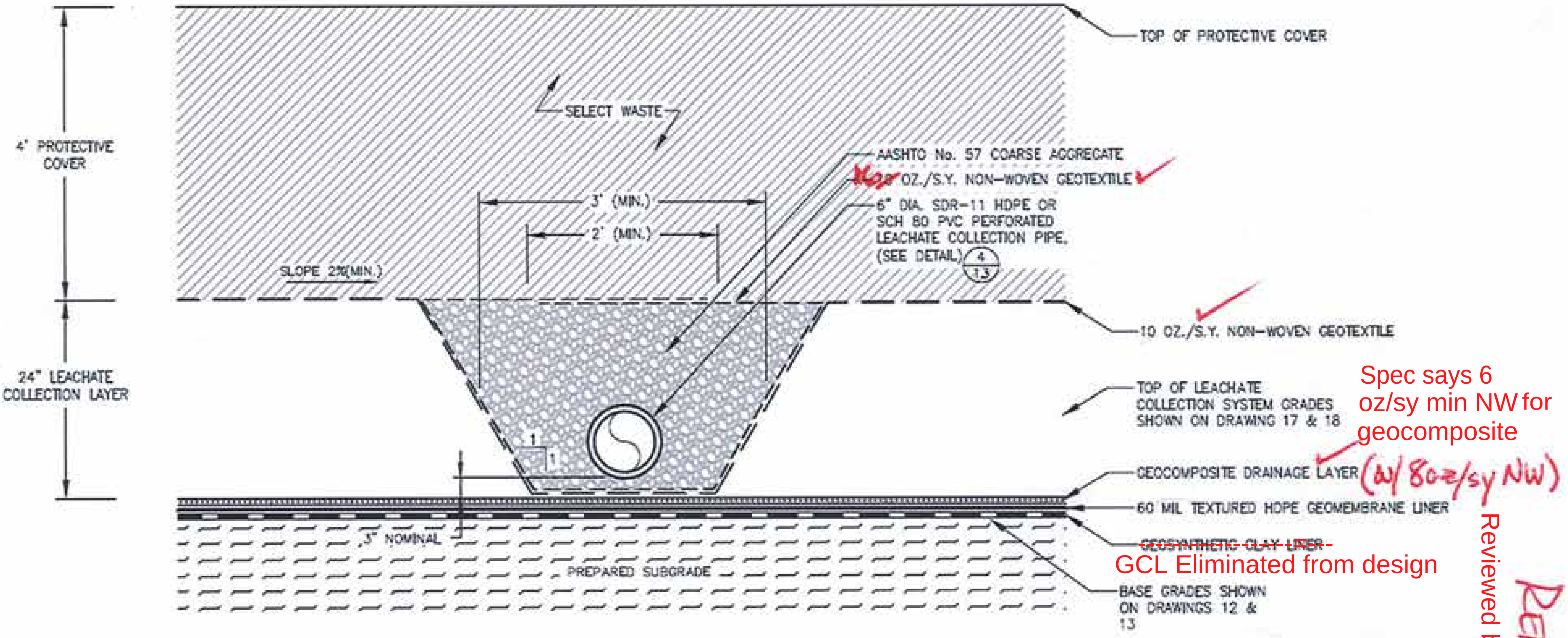
Abbreviation: N/R = Not recommended

Lastly, the entry of ">1.5" for a 12 mm cone height associated with a 550 g/m^2 geotextile is felt to be appropriate considering the following items.

- The geotextiles used at present are made from polypropylene fibers versus the tested geotextiles which were made from polyester fibers. Since the specific gravity of PP is 0.91 and that of PET is between 1.22 and 1.38, one has from 25% to 34% more filaments in an equivalent mass per unit area geotextile using polypropylene fibers. This provides for considerably greater protection capability.
- The area of yield for the six $\simeq$ 12 mm cone heights was extremely small and the thicknesses of the remaining geomembrane was such that considerable deformation could still be sustained before break is even close to occurring.
- The ">1.5" recommendation is precisely for additional conservatism and safety and if a designer wishes to be more conservative than the new recommended table suggests he/she is free to do so.

REFERENCE 4 Pg 1/1

Reviewed by PGS 08/26/2021



1/20 LEACHATE COLLECTION PIPE

NOT TO SCALE

TOTAL NON-WOVEN GEOTEXTILE DIRECTLY BENEATH THE #57 STONE = (16 + 10 + 8) oz/sy = 34 oz/sy
6 32

REFERENCE 5
pg 1/2

901 Aggregate

901.01

This Section includes the material details, quality requirements, and test methods applicable to aggregates. Grading requirements are outlined in Tables 901 A and 901 C; physical properties in 901 B and 901 D. Force drying may be used in the preparation of samples for grading tests conducted in the field.

TABLE 901 A
AGGREGATE GRADING REQUIREMENTS - T 27

MATERIALS	**SIEVE SIZE**															
	2-1/2"	**2"**	**1-1/2"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**No. 4**	**No. 8**	**No. 10**	**No. 16**	**No. 30**	**No. 40**	**No. 50**	**No. 100**	**No. 200**
	63 mm	**50 mm**	**37.5 mm**	**25 mm**	**19 mm**	**12.5 mm**	**9.5 mm**	**4.75 mm**	**2.36 mm**	**2.0 mm**	**1.18 mm**	**600 µm**	**425 µm**	**300 µm**	**150 µm**	**75 µm**
CRUSHER RUN AGGREGATE CR -6 (f)(g)	—	100	90-100	—	60-90	—	—	30-60	—	—	—	—	—	—	—	0-15
BANK RUN GRAVEL — SUBBASE	100	—	—	90-100	—	60-100	—	—	—	35-90	—	—	20-55	—	—	5-25
GRADED AGGREGATE — BASE DESIGN RANGE (a)	—	100	95-100	—	70-92	—	50-70	35-55	—	—	—	12-25	—	—	—	0-8
TOLERANCE (b)	—	(-)2	± 5	—	± 8	—	± 8	± 8	—	—	—	± 5	—	—	—	±3 (c)
BANK RUN GRAVEL — BASE	100	—	—	85-100	—	60-100	—	—	—	35-75	—	—	20-50	—	—	3-20

REFERENCE 5

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				1½"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#30	#40	#50	#100	#200
COARSE AGGREGATE - PORTLAND CEMENT CONCRETE	57 and UNDER DRAIN (h)	—	—	100	95-100	—	25-60	—	0-10	0-5	—	—	—	—	—	—	—
	67	—	—	—	100	90-100	—	20-55	0-10	0-5	—	—	—	—	—	—	—
	7	—	—	—	—	100	90-100	40-70	0-15	0-5	—	—	—	—	—	—	—
FINE AGGREGATE — PORTLAND CEMENT CONCRETE, UNDERDRAIN, and PNEUMATIC MORTAR (d)		—	—	—	—	—	—	100	95-100	—	—	45-85	—	—	5-30	0-10	—
COARSE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	—	—	100	90-100	—	10-50	0-15	—	—	—	—	—	—	—	—
FINE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE (d)		—	—	—	—	—	—	100	85-100	—	—	40-80	—	—	10-35	5-25	—
FINE AGGREGATE/SAND MORTAR and EPOXIES (d)		—	—	—	—	—	—	—	100	95-100	—	—	—	—	—	0-25	0-10
MINERAL FILLER		—	—	—	—	—	—	—	—	—	—	—	100	—	95-100	—	70-100

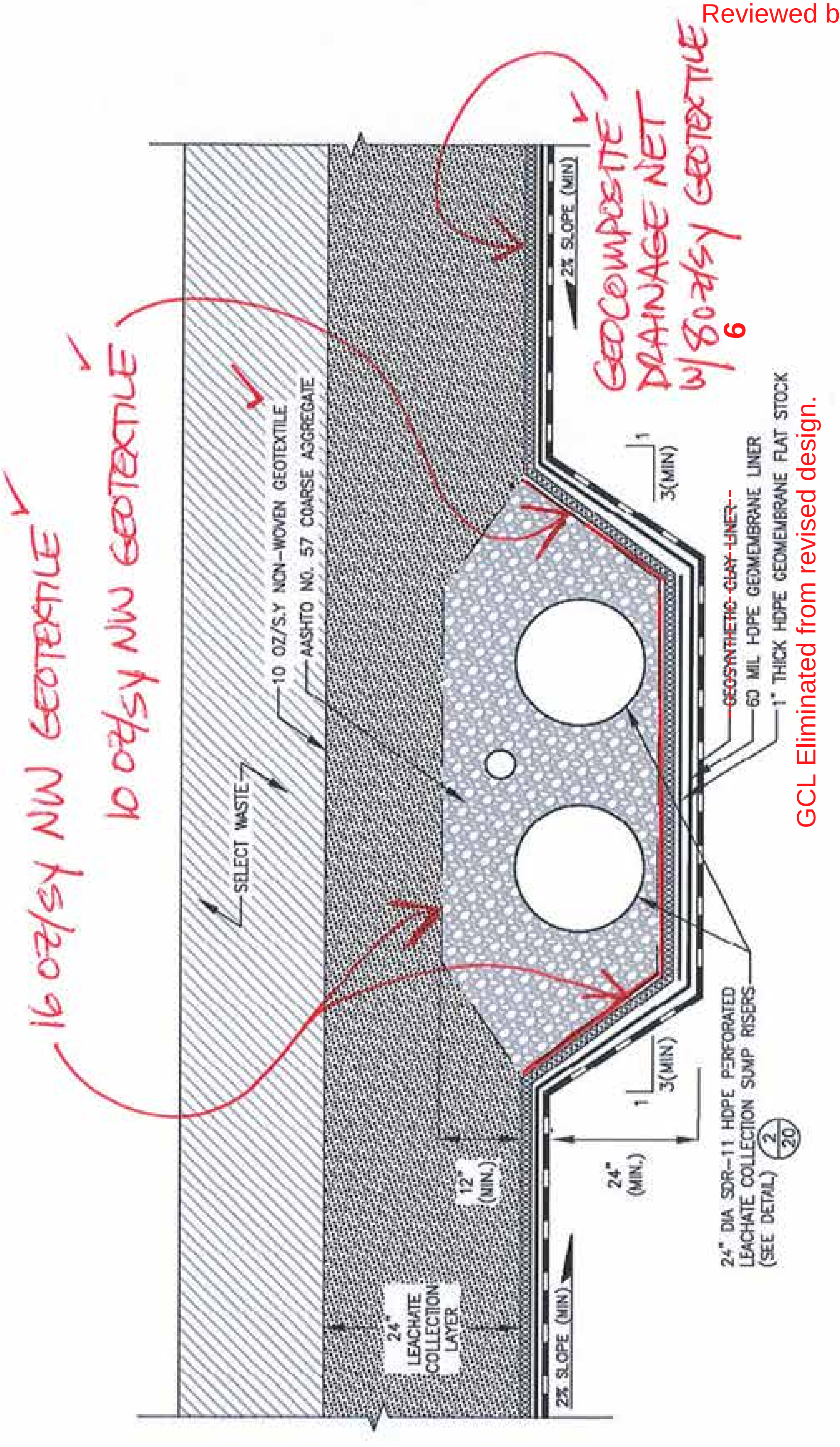
(a) To establish target values for design.

(b) Production tolerance.

REFERENCE 6

Pg 1/1

Reviewed by PGS 08/26/2021



B/20 SECTION B-B' (LEACHATE COLLECTION SUMP)

NOT TO SCALE

LEACHATE COLLECTION SUMP RISERS (SEE DETAIL) 2/20

60 MIL HDPE GEOMEMBRANE LINER

1" THICK HDPE GEOMEMBRANE FLAT STOCK

ATTACHMENT 9D

Liner System Stability

ADVANCED GeoServices a Montrose Environmental Group company	Subject: Liner System - Finite (Veneer) Slope Analysis		
	Job No. 2018-3854	**Made by:** JCA	**Date** 07/15/20
	Ref.	**Checked by:** VEF	**Sheet** 1 of 3

Revised by PGS 09/01/2021

Objective: **Note: Calcs. rerun by PGS 09/01/2021 to eliminate GCL**

The objective of this analysis is to evaluate the veneer stability of the liner and leachate collection system on the 3H: 1V (33%) interior sideslopes under drained conditions for static and dynamic loading. Undrained conditions were not evaluated as the design provides for open, free-drainage at the toe of bottom sideslopes along the perimeter of the landfill.

Design Approach and Assumptions:

1. Undrained conditions were not evaluated here as the design provides for open, free-drainage at the toe of interior sideslopes along the perimeter of the landfill.

2. The proposed liner and leachate collection system consists of the following components:

   4 ft Select Waste;
   Separation Geotextile (10 oz/sy NW-NP-GT);
   2 ft Leachate Collection Sand (SM);
   Geocomposite Drainage Layer (GDL) with NW-NP-GT both sides;
   Textured (on both sides) High Density Polyethylene (HDPE-T) Geomembrane; and
   Prepared Earthen Subgrade.

3. It was assumed that the soils and leachate collection sand have uniform properties: unit weight of 115 pcf, and internal friction angle of 28 degrees.

4. The following interface friction angle (δ) values were considered based on Reference 5:

   Protective Layer to NW-NW-GT: 27 deg;
   NW-NP-GT to SM soil: 27 deg;
   SM soil to GDN w/NW-NP-GT: 27 deg;
   GDN w/NW-NP-GT to HDPE-T: 26 deg;
   HDPE-T to GCL: 23 deg; and,
   HDPE-T to prepared Earthen Subgrade: 18 deg. Assumed cohesive soil Subbase saturated.
   HDPE-T to prepared Earthen Subgrade: 24 deg. Assumed granular soil Subbase.

   For design, a δ value of 18 deg was used. Interface friction testing must be performed for the actual subbase soil proposed to be utilized on the interior cell side slopes.

   Additionally, soil cohesion (c) was ignored to be conservative. Interface adhesion (c_a) was considered since the soil cover loading is great enough to expect interface contact between geosynthetic layers to be good. Reference 5 indicates a c_a value of 10 kPa (209 psf) could be

Revised by PGS 09/01/2021

associated with the HDPE-T to GCL interface. This analysis used a c_a value of 1 kPa (20.9 psf).

5. The target factors of safety (FS) against veneer instability are 1.5 for static and construction loading, and 1.0 for seismic loading. The target FS of 1.5 was adopted based on the assumption the site is for non-hazard waste and high in importance ranking.

6. From the USGS seismic map, the seismic coefficient (C_s, peak ground acceleration) at the site is approximately 0.065g. Reference 6 advocates the use of 0.5(C_s) for design.

7. Low ground pressure equipment is typically used for landfill construction over geosynthetics. This analysis assumes the CAT D6N LGP dozer, or similar, to be used in the construction.

8. Interface friction angles were taken from GRI Report #30 (Reference 5).

9. The analyses were performed following Koerner and Soong 2005 (Reference 1). Only drained conditions were considered as the leachate collection system is designed with key points of collection piping and GDL to prevent undrained conditions. The undrained conditions of horizontal seepage build up and parallel slope seepage buildup were not considered.

Calculations:

The summary of the calculated FS values is shown the following table:

Scenario	**Target Factor of Safety, FS_{min}**	**8-ft Slope (Cohesive) Calculated Factor of Safety, FS**	**12-ft Slope (Cohesive) Calculated Factor of Safety, FS**	**68-ft Slope (Cohesive) Calculated Factor of Safety, FS**	**68-ft Slope (Granular) Calculated Factor of Safety, FS**
Case 1. Static, Drained	1.5	**3.6**	**2.0**	**1.1**	**1.5**
Case 2. Dynamic, Drained, CAT D6N LGP Pushing Upslope	1.5	**2.1**	**1.7**	**1.1**	**1.5**
Case 3. Dynamic, Drained, CAT D6N LGP Pushing Downslope	1.5	**1.7**	**1.4**	**1.1**	**1.4**
Case 6. Dynamic, Drained, Seismic Loading	1.0	**1.5**	**1.5**	**0.7**	**1.0**

Color legend: green = acceptable; red = not acceptable.

Revised by PGS 09/01/2021

CONCLUSIONS:

Based on the foregoing, the following conclusions are presented:

1. The analysis indicates acceptable FS values at the proposed interior slope of the landfill with heights equal to or less than 12 feet ft. (1.5 lifts) for cohesive or granular soils. For all conditions except pushing waste down slope.

2. Slopes will be unstable for a <u>cohesive soil Subbase</u> at any height greater than 12 feet. This means that placement of the 2 ft. thick leachate collection layer and 4 ft. thick layer of select waste on the side slopes must be performed as waste placement progresses. Never allowing the difference in elevation between the top of the placed leachate collection and Select Waste layers, and the height of waste to be greater than 12 feet.

3. If permeability and interface friction testing between the textured HDPE and Subbase soil can produce a value of 24 degrees or greater while still meeting the permeability requirements, then the leachate collection layer and Select Waste layers on the side slopes in any of the proposed cells can be can be completed without the need for sequencing the construction with filling.

4. FS values under seismic loading were acceptable for each of the conditions evaluated except the 68 feet high slope constructed with cohesive subbase materials.

5. To successfully accomplish the construction and operation of the landfill with respect to the stability of the liner and leachate collection system, the materials used should meet or exceed the parameters used in this analysis.

References:

1. Koerner, R.M., and Soong, T.Y.; *"Analysis and Design of Veneer Cover Soils"*; Geosynthetics International, 2005, Vol. 12, No.1, p28-49.

2. Soong, T.Y, and Koerner, R.M.; *"Cover Soil Slope Stability Involving Geosynthetic Interfaces"*, GRI Report #18, 1996.

3. Koerner, R.M., and Daniel, D.; *"Final Covers for Solid Waste Landfills and Abandoned Dumps"*, 1997.

4. Soong, T.Y, and Koerner, R.M.; *"The Design of Drainage Systems over Geosynthetically Lined Slopes"*, GRI Report #19, 1997.

Revised by PGS 09/01/2021

5. Koerner, G.R., Narejo, D.; *"Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"*; GRI Report #30, 2005.

6. U.S.E.P.A.; *"RCRA Substitute D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities"*; EPA/600/R-95/051, April, 1995.

7. United States Geologic Survey (USGS); *"Map of Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years"*, Oct. 2002.

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Project: Chesapeake Terrace Design Revisions
P.N.: 2018-3854 **Page:** 1 of 3
By: PGS **Date:** 09/01/21
Checked: **Date:**
Subject: Liner System - Finite (Veneer) 68-ft Slope Analysis

Description

Perform a finite (veneer) slope length analysis of the liner and leachate collection system. To estimate minimum inteface friction required to construct all side slopes layers (leachate collection and Select Waste) in any height cell without need for filling in sections.

Slope Information

Slope, β = 3 *H to 1V =* 18.4 *deg* 2β = 36.87 *deg*
Maximum Slope Length, L = 215 *ft*
Height of Slope, H = 68 *ft*

Materials

Cover Soil = USCS Silty Sand, SM
Cover soil thickness, h = 6 *ft*
Moist unit weight, γ_{moist} = 115 *pcf*
Saturated unit weight, γ_{sat} = 130 *pcf*
Internal friction angle, ϕ = 28 *deg*
Soil cohesion, c = 209 *psf*
Water unit weight, γ_w = 62.4 *pcf*
Textured Geomembrane = 60-mil HDPE-T
Subbase = Subbase

Interface Friction Angles

Protective Cover Soil to NW-NP-GT, δ_4 = 27 *deg*
NW-NP-GT to Leachate Collection Layer, δ_5 = 27 *deg*
Leachate Collection Layer to GDN, δ_6 = 27 *deg*
GDN to HDPE-T, δ_7 = 26 *deg*
HDPE-T to Subbase Soil, δ_8 = 24 *deg*
All interface adhesion, c_a = 1 kPa = 20.9 *psf*

Use δ = 24 *deg*

Calc performed for δ8 = 24, C=0.0 psf

Case 1: Static, Drained

sin β =	0.32	W_A =	135,972	*lb/ft*
tan β =	0.33	W_P =	6,900	*lb/ft*
cos β =	0.95	N_A =	128,995	*lb/ft*
sin $^2\beta$ =	0.10	C_a =	4,096	*lb/ft*
sin 2β =	0.60	*C =*	0	*lb/ft*
tan ϕ =	0.53	*a =*	12,899	*lb/ft*
tan δ =	0.45	*b =*	-21,905	*lb/ft*
		c =	3,271	*lb/ft*

Minimum Factor of Safety, FSmin = 1.5
Factor of Safety, FS = 1.53

Case 2: Dynamic, Drained, Equipment Pushing Upslope

$\sin\beta$ =	0.32	W_A =	135,972	lb/ft	q =	685	lb/ft
$\tan\beta$ =	0.33	W_P =	6,900	lb/ft	We =	6,565	lb/ft
$\cos\beta$ =	0.95	N_A =	128,995	lb/ft	Ne =	6,228	lb/ft
$\sin^2\beta$ =	0.10	C_a =	4,096	lb/ft			
$\sin 2\beta$ =	0.60	C =	0	lb/ft			
$\tan\phi$ =	0.53	a =	42,761	lb/ft			
$\tan\delta$ =	0.45	b =	-72,249	lb/ft			
		c =	10,812	lb/ft			

Weight of Equipment, W_b = 39,112

Length of Equipment Track, w = 10.2

Width of Equipment Track, b = 2.8

Width-to-Thickness Ratio, b/h = 0.5

Influence Factor, I = 0.94

Minimum Factor of Safety, FSmin = 1.5

Factor of Safety, FS = 1.52

Case 3: Dynamic, Drained, Equipment Pushing Downslope

$\sin\beta$ =	0.32	W_A =	135,972	lb/ft	q =	685	lb/ft
$\tan\beta$ =	0.33	W_P =	6,900	lb/ft	We =	6,565	lb/ft
$\cos\beta$ =	0.95	N_A =	128,995	lb/ft	Ne =	6,228	lb/ft
$\sin^2\beta$ =	0.10	C_a =	4,096	lb/ft	Fe =	985	lb/ft
$\sin 2\beta$ =	0.60	C =	0	lb/ft			lb/ft
$\tan\phi$ =	0.53	a =	43,695	lb/ft			
$\tan\delta$ =	0.45	b =	-72,414	lb/ft			
		c =	10,812	lb/ft			

Dozer-to-Gravity Acceleration Ratio, a/g = 0.15

Acceleration of Dozer, a_d = 4.827 ft/s^2

Anticipated speed = 15 mi/hr

= 24.1 km/h

Time to speed = 4 s

Minimum Factor of Safety, FSmin = 1.5

Factor of Safety, FS = 1.49

Case 4: Static, Undrained, Horizontal Seepage Build-up to 1-ft Depth

$\sin\beta$ =	0.32	W_A =	140,859	lb/ft	Uv =	3,370	lb/ft
$\tan\beta$ =	0.33	W_P =	7,800	lb/ft	Uh =	1,123	lb/ft
$\cos\beta$ =	0.95	N_A =	136,414	lb/ft	Un =	-2,429	lb/ft
$\sin^2\beta$ =	0.10	C_a =	4,096	lb/ft			
$\sin 2\beta$ =	0.60	C =	0	lb/ft			
$\tan\phi$ =	0.53	a =	42,370	lb/ft			
$\tan\delta$ =	0.45	b =	-71,170	lb/ft			
		c =	10,901	lb/ft			

Height from Toe to Water, Hw = 1.0 ft

Saturated Soil Unit Weight, γ_{sat} = 130 pcf

Horizontal Submergence Ratio, HSR = Hw/H = 0.015

Minimum Factor of Safety, FSmin = 1.5

Factor of Safety, FS = 1.51

Case 6: Dynamic, Drained, Seismic Loading

sin β =	0.32		*W_A =*	135,264	*lb/ft*	
tan β =	0.33		*W_P =*	6,900	*lb/ft*	
cos β =	0.95		*N_A =*	128,323	*lb/ft*	
$\sin^2\beta$ =	0.10		*C_a =*	4,096	*lb/ft*	
sin 2β =	0.60		*C =*	0	*lb/ft*	
tan ϕ =	0.53		*a =*	46,624	*lb/ft*	482
tan δ =	0.45		*b =*	-58,776	*lb/ft*	-459
Seismic coefficient, Cs =	0.065		*c =*	9,767	*lb/ft*	135
(0.5)Cs =	0.0325	*>>>Use (Reference 6)*				

Minimum Factor of Safety, FSmin = 1.0

Factor of Safety, FS = 1.06

References:

1 *Koerner, R.M., and Soong, T.Y.; "Analysis and Design of Veneer Cover Soils"; Geosynthetics International, 2005, Vol. 12, No.1, p28-49.*

2 *Soong, T.Y, and Koerner, R.M.; "Cover Soil Slope Stability Involving Geosynthetic Interfaces", GRI Report #18, 1996.*

3 *Koerner, R.M., and Daniel, D.; "Final Covers for Solid Waste Landfills and Abandoned Dumps", 1997.*

4 *Soong, T.Y, and Koerner, R.M.; "The Design of Drainage Systems over Geosynthetically Lined Slopes"; , GRI Report #19, 1997.*

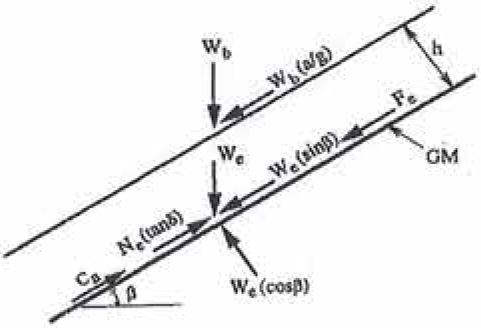
5 *Koerner, G.R., Narejo, D.; "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"; GRI Report #30, 2005.*

6 *U.S.E.P.A.; "RCRA Substitute D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities"; EPA/600/R-95/051, April, 1995.*

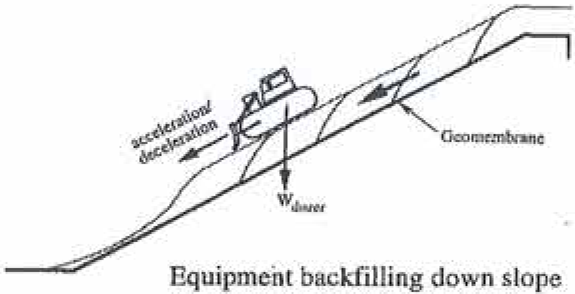
7 *Map of Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years, USGS Map, Oct. 2002.*

REFERENCE 1 pg 3/6

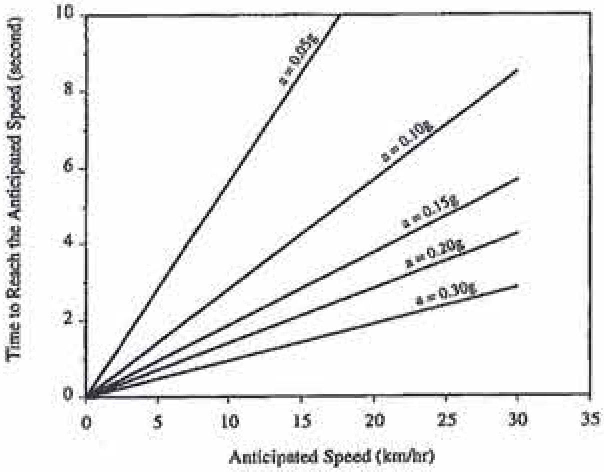
Case 3: Drained, Equipment Pushing Downslope



Equipment moving down slope
(load plus acceleration or deceleration)



Equipment backfilling down slope
(method is not recommended)



- W_A, W_P, N_A, Ca, C, and FS same as Case 1

- We, q, and Ne same as Case 2

$$\boxed{F_e = W_e \cdot \left(\frac{a}{g}\right)}$$

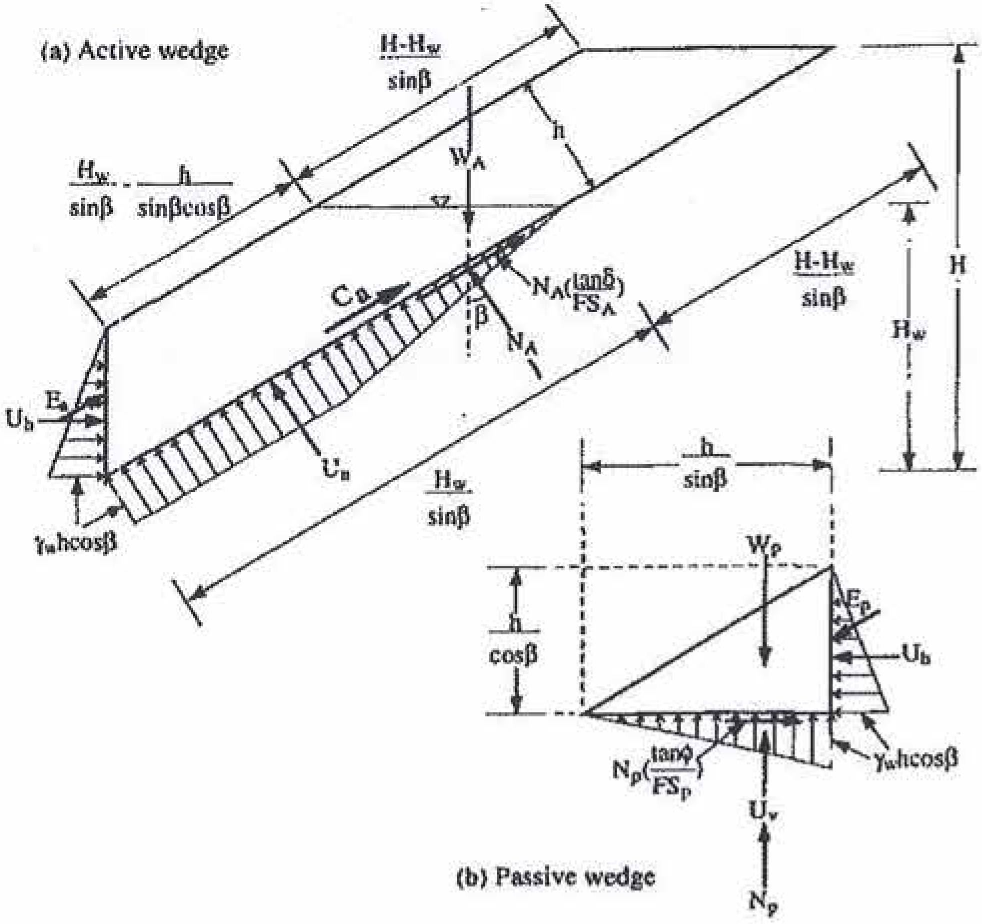
$$\boxed{a = [(W_A + W_e) \cdot \sin\beta + F_e] \cdot \cos\beta}$$

$$\boxed{c = [(N_e + N_A) \cdot \tan\delta + C_a] \cdot \sin\beta \cdot \tan\phi}$$

$$\boxed{b = -\{[(N_e + N_A) \cdot \tan\delta + C_a] \cdot \cos\beta + [(W_A + W_e) \cdot \sin\beta + F_e] \cdot \sin\beta \cdot \tan\phi + (C + W_P \cdot \tan\phi)\}}$$

REFERENCE1
pg 4/6

Case 4: Horizontal Seepage Build-up



$$W_A = \gamma_{sat} \cdot h \cdot \left(\frac{2 \cdot Hw \cdot \cos\beta - h}{\sin 2\beta} \right) + \gamma_{moist} \cdot h \cdot \left(\frac{H - Hw}{\sin\beta} \right)$$

$$W_P = \frac{h^2 \cdot \gamma_{sat}}{\sin 2\beta}$$

$$U_v = \frac{h^2 \cdot \gamma_w}{2 \tan\beta}$$

$$U_h = \frac{h^2 \cdot \gamma_w}{2}$$

$$U_N = \gamma_w \cdot h \cdot \cos\beta \cdot \left(\frac{2 \cdot Hw \cdot \cos\beta - h}{\sin 2\beta} \right)$$

$$N_A = W_A \cdot \cos\beta + U_h \cdot \sin\beta - U_N$$

- Ca, C, and FS same Case 1

$$a = W_A \cdot \sin\beta \cdot \cos\beta - U_h \cdot \cos^2\beta + U_h$$

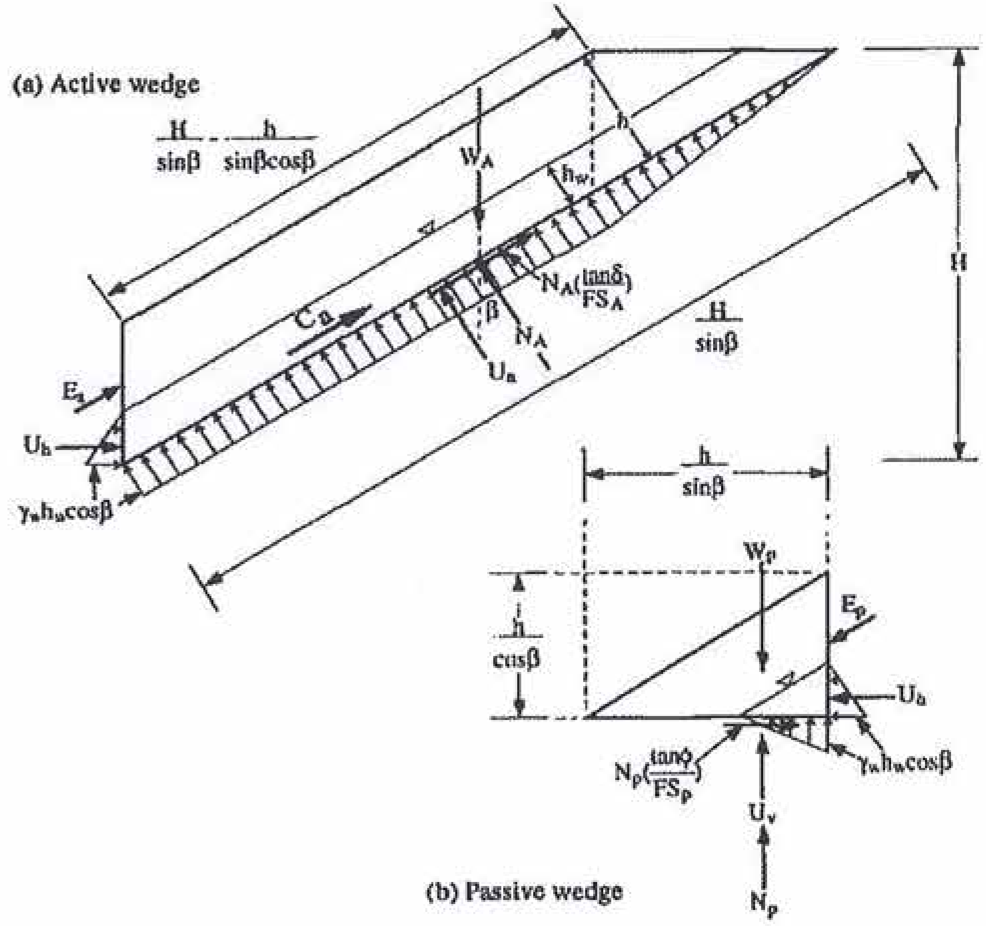
$$c = (N_A \cdot \tan\delta + Ca) \cdot \sin\beta \cdot \tan\phi$$

$$b = -W_A \cdot \sin^2\beta \cdot \tan\phi + U_h \cdot \cos\beta \cdot \sin\beta \cdot \tan\phi - (N_A \cdot \tan\delta + Ca) \cdot \cos\beta - [(W_P - U_v) \cdot \tan\phi]$$

- Koerner and Soong equations for a, b, and c are modified to include Ca.

REFERENCE 1 pg 5/6

Case 5: Parallel Seepage Build-up



$$W_A = \frac{\gamma_{moist} \cdot (h - h_w) \cdot \left[2H \cdot \cos\beta - (h + h_w)\right]}{\sin 2\beta} + \frac{\gamma_{sat} \cdot h_w \cdot (2H \cdot \cos\beta - h_w)}{\sin 2\beta}$$

$$W_P = \frac{\gamma_{moist} \cdot (h^2 - h_w{}^2) + h_w{}^2 \cdot \gamma_{sat}}{\sin 2\beta}$$

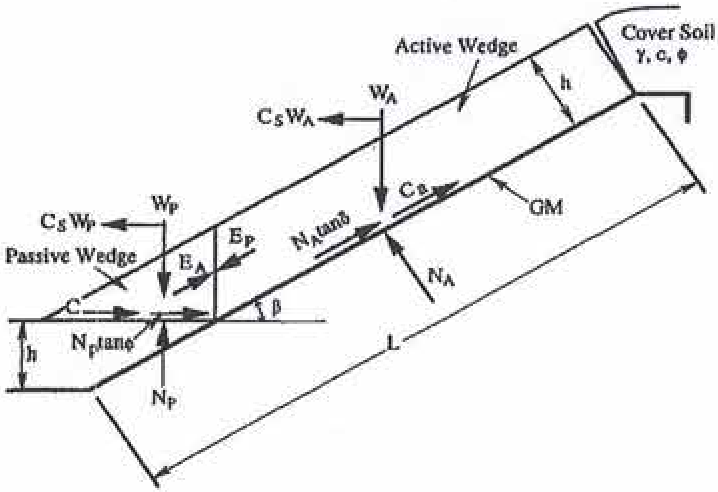
- Ca, C, and FS same as Case 1
- a, b, c, Uv, and NA same as Case 4

$$U_N = \frac{\gamma_w \cdot h_w \cdot \cos\beta \cdot (2H \cdot \cos\beta - h_w)}{\sin 2\beta}$$

$$U_h = \frac{\gamma_w \cdot h_w{}^2}{2}$$

REFERENCE 1 pg 6/6

Case 6: Drained, Seismic Affect



- **Wa, Wp, Na, Ca, C, and FS same as Case 1**

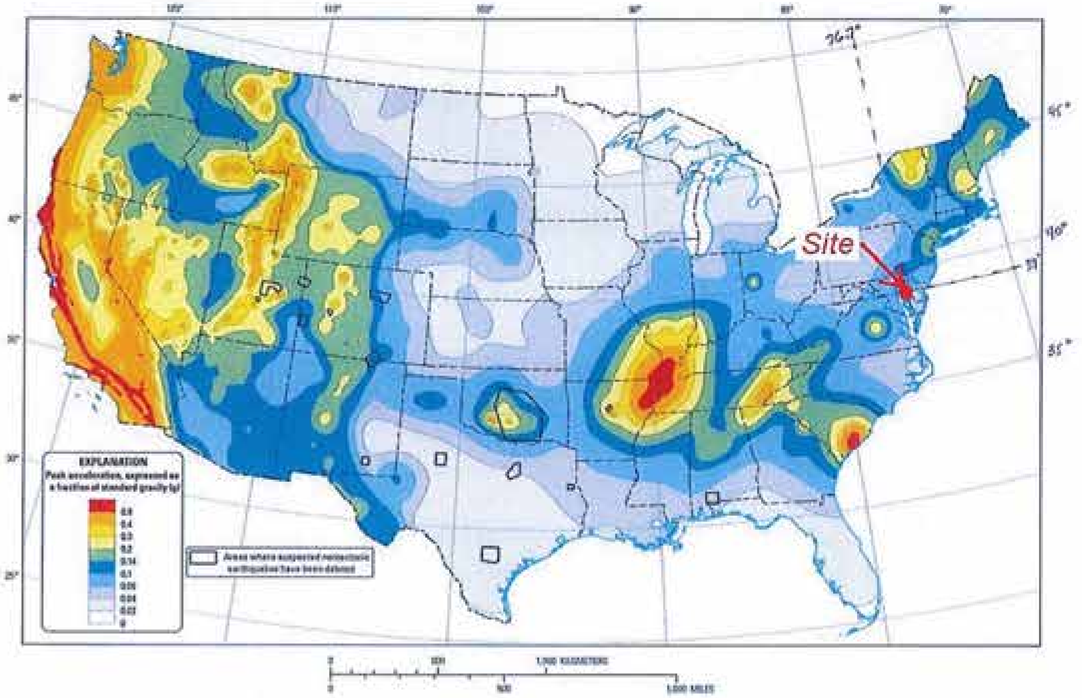
$$\boxed{a = (C_s \cdot W_A + N_A \cdot \sin\beta) \cdot \cos\beta + C_s \cdot W_P \cdot \cos\beta}$$

$$\boxed{c = (N_A \cdot \tan\delta + C_a) \cdot \cos\beta \cdot \sin\beta \cdot \tan\phi}$$

$$\boxed{b = -[(C_s \cdot W_A + N_A \cdot \sin\beta) \cdot \sin\beta \cdot \tan\phi + (N_A \cdot \tan\delta + C_a) \cdot \cos^2\beta + (C + W_P \cdot \tan\phi) \cdot \cos\beta]}$$

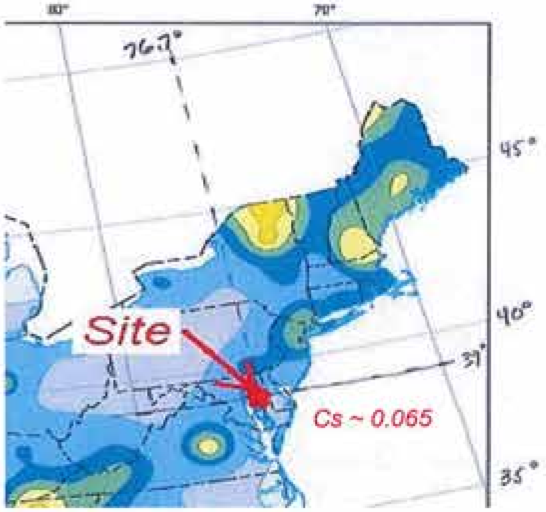
REFERENCE 7 Pg 1/2

Case 6: Drained, Seismic Affect (cont.)



Two-percent probability of exceedance in 50 years map of peak ground acceleration

https://earthquake.usgs.gov/hazards/hazmaps/



Approximate Site Location

Two-percent probability of exceedance in 50 years map of peak ground acceleration

https://earthquake.usgs.gov/hazards/hazmaps/

ADVANCED GeoServices
a Montrose Environmental Group company

Project: Chesapeake Terrace
P.N.: 2018-3854 **Page:** 1 of 1
By: JCA **Date:** 10-Oct-19
Checked: VEF **Date:** 7/14/20
Subject: Finite (Veneer) Slope Analysis -Equipment Data

Caterpillar Performance Handbook (Edition 32, October 2001)

Model	Unit	D4G LGP Hystat	D6R	D6R LGP	D7R LGP Series II	D8R	D9R	D10R	***D6N LGP***[(1)]
Weight of Equipment, W_b	lb	17,877	40,400	45,600	60,300	82,850	107,670	144,200	***39,112***
Length of Equipment Track, w	in	80.9	103	128	125	126	137	153	***122.7***
	ft	6.7	8.6	10.7	10.4	10.5	11.4	12.8	***10.2***
Width of Equipment Track, b	in	25	22	36	36	22	24	24	***33.07***
	ft	2.1	1.8	3.0	3.0	1.8	2.0	2.0	***2.8***
Ground contact area, calculated	in^2	4,045	4,532	9,216	9,000	5,544	6,576	7,344	***8,115***
	ft^2	28.1	31.5	64.0	62.5	38.5	45.7	51.0	***56.4***
Ground contact area, from book	in^2	4,045	4,518	9,194	9,029	5,565	6,569	7,321	***8,122***
	ft^2	28.1	31.4	63.8	62.7	38.6	45.6	50.8	***56.4***
Ground pressures, from book	psi	4.11	8.82	4.94	6.55	14.67	16.08	19.63	***4.8***
	psf	592	1270	711	943	2112	2316	2827	***691***
Ground pressures, calculated	psi	4.42	8.91	4.95	6.70	14.94	16.37	19.64	***4.82***
	psf	636	1,284	713	965	2,152	2,358	2,827	***694***

Reference

1 *D6N track-type tractor product literature; www.cat.com.*

REFERENCE 5
pg 1/2

Appendix Table 1. Summary of interface shear strengths.

δ

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
HDPE-S	Granular Soil	1a	21	0	162	0.93	1b	17	0	128	0.92
HDPE-S	Cohesive Soil										
	Saturated	1c	11	7	79	0.94	1d	11	0	59	0.95
	Unsaturated	1c	22	0	44	0.93	1d	18	0	32	0.93
HDPE-S	NW-NP GT	1e	11	0	149	0.93	1f	9	0	82	0.96
HDPE-S	Geonet	1g	11	0	196	0.90	1h	9	0	118	0.93
HDPE-S	Geocomposite	1i	15	0	36	0.97	1j	12	0	30	0.93
HDPE-T	Granular Soil	2a	34	0	251	0.98	2b	31	0	239	0.96
HDPE-T	Cohesive Soil										
	Saturated	2c	18	10	167	0.93	2d	16	0	150	0.90
	Unsaturated	2c	19	23	62	0.91	2d	22	0	35	0.93
HDPE-T	NW-NP GT	2e	25	8	254	0.96	2f	17	0	217	0.95
HDPE-T	Geonet	2g	13	0	31	0.99	2h	10	0	27	0.99
HDPE-T 7	Geocomposite	2i	26*	0	168	0.95	2j	15	0	164	0.94
LLDPE-S	Granular Soil	3a	27	0	6	1.00	3b	24	0	9	1.00
LLDPE-S	Cohesive Soil	3c	11	12.4	12	0.94	3d	12	3.7	9	0.93
LLDPE-S	NW-NP GT	3e	10	0	23	0.63	3f	9	0	23	0.49
LLDPE-S	Geonet	3g	11	0	9	0.99	3h	10	0	9	1.00
LLDPE-T 3	Granular Soil	4a	26*	7.7	12	0.95	4b	25	5.2	12	0.95
LLDPE-T	Cohesive Soil	4c	21	5.8	12	1.00	4d	13	7.0	9	0.98
LLDPE-T 2	NW-NP GT	4e	26*	8.1	9	1.00	4f	17	9.5	9	0.96
LLDPE-T	Geonet	4g	15	3.6	6	0.97	4h	11	0	6	0.98
PVC-S	Granular Soil	5a	26	0.4	6	0.99	5b	19	0	6	0.99
PVC-S	Cohesive Soil	5c	22	0.9	11	0.88	5d	15	0	9	0.95
PVC-S	NW-NP GT	5e	20	0	89	0.91	5f	16	0	83	0.74
PVC-S	NW-HB GT	5g	18	0	3	1.00	5h	12	0.1	3	1.00
PVC-S	Woven GT	5i	17	0	6	0.54	5j	7	0	6	0.93
PVC-S	Geonet	5k	18	0.1	3	1.00	5l	16	0.6	3	1.00

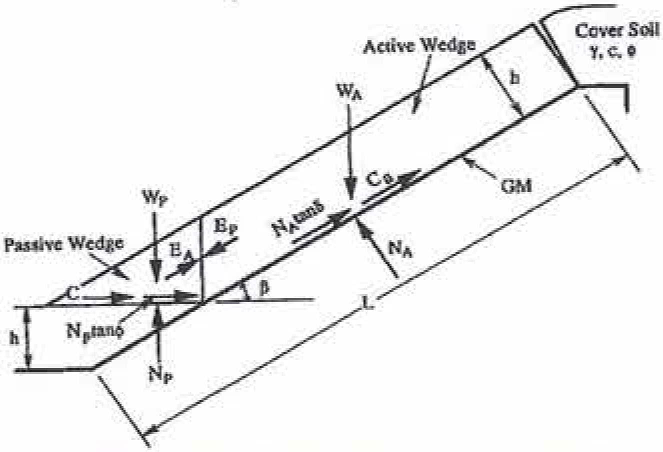
REFERENCE 5 Pg 2/2

Appendix Table 1. (continued)

Interface 1* δ ↓	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
PVC-F	NW-NP GT	6a	27	0.2	26	0.95	6b	23	0	26	0.95
PVC-F	NW-HB GT	6c	30	0	8	0.97	6d	27	0	8	0.90
PVC-F	Woven GT	6e	15	0	6	0.78	6f	10	0	6	0.76
PVC-F	Geonet	6g	25	0	11	1.00	6h	19	0	11	0.99
PVC-F	Geocomposite	6i	27	1.1	5	1.00	6j	22	4.7	6	1.00
CSPE-R	Granular Soil	7a	36	0	3	1.00	7b	16	0	3	1.00
CSPE-R	Cohesive Soil	7c	31	5.7	6	0.71	7d	18	0	6	0.99
CSPE-R	NW-NP GT	7e	14	0	6	0.97	7f	10	0	6	0.98
CSPE-R	NW-HB GT	7g	21	0	3	1.00	7h	10	0	3	1.00
CSPE-R	Woven GT	7i	11	0	6	0.92	7j	11	0	3	1.00
CSPE-R	Geonet	7k	28	0	9	0.87	7l	16	0	9	0.80
NW-NP GT	Granular Soil	8a	33	0	290	0.97	8b	33	0	117	0.96
NW-HB GT	Granular Soil	8c	28	0	6	0.99	8d	16	0	6	0.91
Woven GT	Granular Soil	8e	32	0	81	0.99	8f	29	0	28	0.98
NW-NP GT	Cohesive Soil	9a	30	5	79	0.96	9b	21	0	28	0.79
NW-HB GT	Cohesive Soil	9c	29	0.9	15	0.71	9d	10	0	15	0.83
Woven GT	Cohesive Soil	9e	29	0	34	0.94	9f	19	0	16	0.86
GCL Reinforced (internal)	N/A	10a	16	38	406	0.85	10b	6	12	182	0.91
GCL (NW-NP GT) &	HDPE-T	11a	23 *	8	180	0.95	11b	13	0	157	0.90
GCL (W-SF GT)	HDPE-T	11c	18	11	196	0.96	11d	12	0	153	0.92
Geonet	NW-NP GT	12a	23	0	52	0.97	12b	16	0	32	0.97
Geocomposite 1,4,5, (NW-NP GT) 6,9	Granular Soil	13a	27 *	14	14	0.86	13b	21	8	10	0.92

REFERENCE 1 pg 1/6

Case 1: Drained



Limit equilibrium forces in a finite length slope analysis for a uniformly thick cover soil.

$$\boxed{W_A = \gamma_{moist} \cdot h^2 \cdot \left[\frac{L}{h} - \frac{1}{\sin\beta} + \frac{\tan\beta}{2}\right]}$$

$$\boxed{W_P = \frac{h^2 \cdot \gamma_{moist}}{\sin 2\beta}} \quad \boxed{N_A = W_A \cdot \cos\beta}$$

$$\boxed{C_a = c_a \cdot \left(L - \frac{h}{\sin\beta}\right)} \quad \boxed{C = \frac{c \cdot h}{\sin\beta}}$$

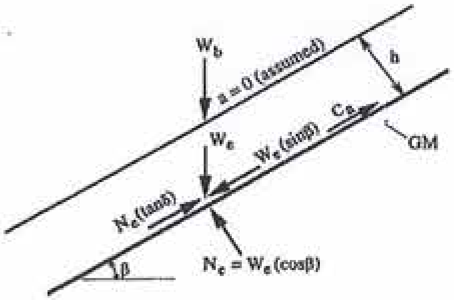
$$\boxed{a = (W_A - N_A \cdot \cos\beta) \cdot \cos\beta} \qquad \boxed{c = (N_A \cdot \tan\delta + C_a) \cdot \sin^2\beta \cdot \tan\phi}$$

$$\boxed{b = -[(W_A - N_A \cdot \cos\beta) \cdot \sin\beta \cdot \tan\phi + (N_A \cdot \tan\delta + C_a) \cdot \sin\beta \cdot \cos\beta + \sin\beta \cdot (C + W_P \cdot \tan\phi)]}$$

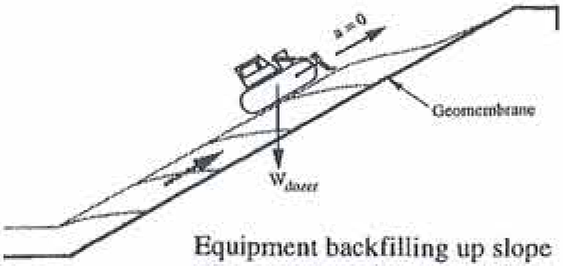
$$\boxed{FS = \frac{-b + \sqrt{b^2 - 4a \cdot c}}{2a}}$$

REFERENCE 1

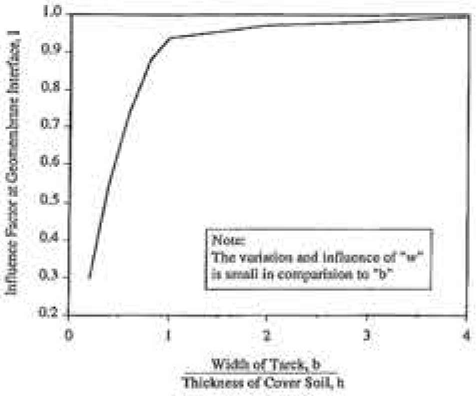
Case 2: Drained, Equipment Pushing Upslope



Equipment moving up slope
(load with no assumed acceleration)



Equipment backfilling up slope
(the recommended method)



- W_A, W_P, N_A, Ca, C, and FS same as Case 1

$$\boxed{q = \frac{W_b}{(2 \cdot w \cdot b)}}$$

$$\boxed{W_e = q \cdot w \cdot I}$$

$$\boxed{N_e = W_e \cdot \cos\beta}$$

$$\boxed{a = [(W_A + W_e) \cdot \sin\beta] \cdot \cos\beta}$$

$$\boxed{c = [(N_e + N_A) \cdot \tan\delta + C_a] \cdot \sin\beta \cdot \tan\phi}$$

$$\boxed{b = -\{[(N_e + N_A) \cdot \tan\delta + C_a] \cdot \cos\beta + [(W_A + W_e) \cdot \sin\beta] \cdot \sin\beta \cdot \tan\phi + (C + W_P \cdot \tan\phi)\}}$$

ATTACHMENT 9E

Subgrade Bearing Capacity

ADVANCED GeoServices
a Montrose Environmental Group company

Subject: Bearing Capacity		
Job No. 2018-3854	**Made by:** JCA	**Date:** 07/15/20
Ref.	**Checked by:** VEF	**Sheet** 1 of 8

Reviewed by PGS 09/01/2021

These calculations were prepared for the maximum fill levels proposed in the July 2020 design submission. They are still acceptable for the reduced top of cap elevations because the load will be equal to or less than the previous calculated values.

1. Purpose

The purpose of this analysis is to estimate the bearing capacity of the soils beneath the landfill, and estimate the factor of safety when compared to the anticipated landfill loads.

2. Analysis Approach

Any discussion of bearing capacity invariably starts with a discussion of the work by Terzaghi and Peck. Terzaghi's bearing capacity formulae form the basis for nearly every treatise on foundation design and analysis. The initial application of Terzaghi's bearing capacity work was to the design of shallow foundations (strip or continuous, square, circular, etc.). It has become acceptable to apply Terzaghi's work to the bearing capacity of the subsoils beneath a landfill.

The approach used in this analysis is that used by Szypcio and Dolzyk (2006). Szypcio and Dolzyk calculated bearing capacity of layered subsoils based on Terzaghi's formula, and treated the layered subsoil as a homogenous layer with average parameters. For this analysis, the average parameters are weighted averages based on soil layer thicknesses and the depth below the landfill that would be expected to influenced bearing capacity. The applied bearing pressures due to the landfill were taken from the settlement analysis for this project. To be conservative, this analysis considers the minimum factor of safety for bearing capacity to be 3.

3. Bearing Capacity Points of Interest

Locations of approximate greatest waste thickness were chosen for the settlement analysis. Therefore, these locations were chosen for bearing capacity analysis. For Cell 13, this location is in close proximity to the upgradient end of the main leachate collection pipe in the cell. This location is designated as "Cell 13, Point 3" in the settlement analysis. In Cell 10, the location of greatest waste thickness is located along the main leachate collection pipe, between the sump and the upgradient end of the pipe. This location is designated as "Cell 10, Point 4" in the settlement analysis. These points were chosen for bearing capacity analysis.

The following table summarizes general data for these locations.

Cell and Point	Top of Landfill Elev. (ft)	Bottom of Landfill Elev. (ft)	Waste Depth [(a)] (ft)
Cell 10, Point 4	270	118	143 ✓
Cell 13, Point 3	202	94	99 ✓

Note (a): Cap and Cover thickness = 3 ft; Liner and Leachate Collection thickness = 6 ft.

At these locations, the soil profiles developed for the settlement analysis were used.

Reviewed by PGS 09/01/2021

4. Correlation of Soil Properties

a. Soil Unit Weight

The soil unit weight was correlated with the N-value from the Standard Penetration Tests (SPT) performed in the various borings at the site, as described in the settlement analysis. This correlation was defined as:

$$\text{Non-Cohesive Soils:} \quad \gamma = 0.001(N^3) - 0.0695(N^2) + 2.0802(N) + 89.265$$

$$\text{Cohesive Soils:} \quad \gamma = 0.0027(N^3) - 0.1536(N^2) + 3.8139(N) + 90.869$$

b. Cohesion

Cohesion for cohesive soils was estimated using the correlation presented by Kumar 2016 (after Karol 1960), as follows:

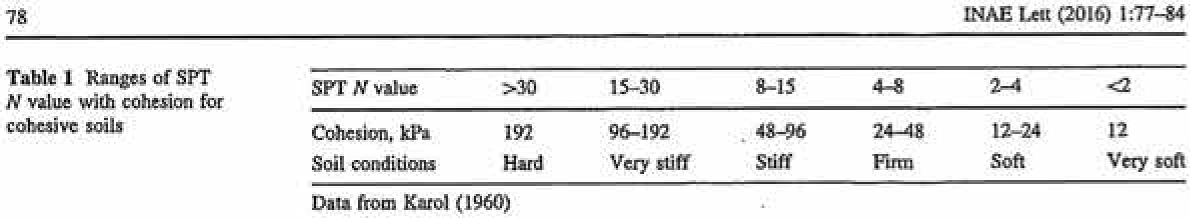


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Table 1 Ranges of SPT *N* value with cohesion for cohesive soils

SPT *N* value	>30	15–30	8–15	4–8	2–4	<2
Cohesion, kPa	192	96–192	48–96	24–48	12–24	12
Soil conditions	Hard	Very stiff	Stiff	Firm	Soft	Very soft

Data from Karol (1960)

This data was used in an Excel spreadsheet to develop the following equation:

$$c = 134.41(N) - 26.51$$

Where:

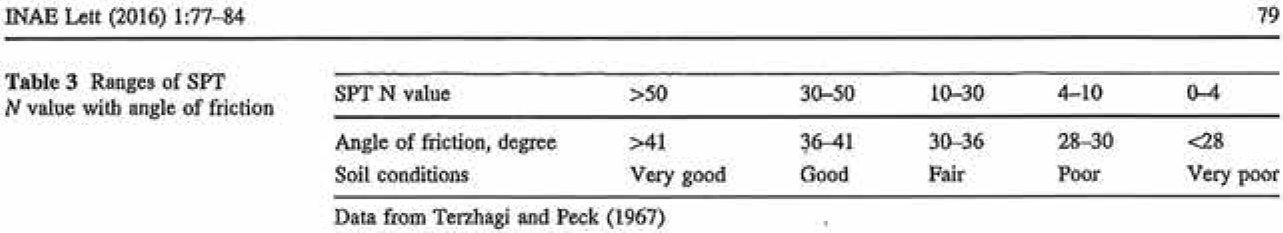
c = cohesion, psf; and,
N = resistance N-value from the SPT

A cohesion value was not calculated for non-cohesive soils.

c. Angle of Internal Friction

The angle of internal friction (phi angle), was estimated using the correlation presented by Kumar 2016 (after Terzaghi and Peck 1967), as follows:

Reviewed by PGS 09/01/2021



INAE Lett (2016) 1:77–84 79

Table 3 Ranges of SPT *N* value with angle of friction

SPT N value	>50	30–50	10–30	4–10	0–4
Angle of friction, degree	>41	36–41	30–36	28–30	<28
Soil conditions	Very good	Good	Fair	Poor	Very poor

Data from Terzhagi and Peck (1967)

This data was used in an Excel spreadsheet to develop the following equation:

$$\phi = 0.2827(N) + 27.106$$

Where:

ϕ = angle of internal. Friction, deg; and,
N = resistance N-value from the SPT

An angle of internal friction value was not calculated non-cohesive soils.

5. Bearing Capacity

As indicated previously, this analysis follows Szypcio and Dolzyk (2006) in that bearing capacity of the layered subsoils is calculated based on Terzaghi's formula. The layered subsoil beneath the bottom of the landfill is treated as a homogenous layer with average unit weight, cohesion, and phi angle parameters. Furthermore, since groundwater is located relatively close to the bottom of the landfill, the unit weight was adjusted for the presence of groundwater.

a. Terzaghi's Formula

Terzaghi's formula for bearing capacity of a square footing was chosen since the shape of the landfill cells is approximately square and rectangular. The formula is given as:

$$q_u = 1.3cN_c + qN_q + 0.4\gamma BN_\gamma$$

Where:

q_u = ultimate bearing capacity of the soil below the foundation (landfill);
c = cohesion;
N_c , N_q , N_γ = bearing capacity factors for cohesion, overburden pressure, and unit weight;
q = overburden pressure;
γ = soil unit weight; and,
B = foundation (landfill cell) width.

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The bearing capacity factors Nc, Nq, and Nγ are taken from the following nomograph (Das 1990, after Terzaghi 1967):

3.3 Terzaghi's Bearing Capacity Theory 125

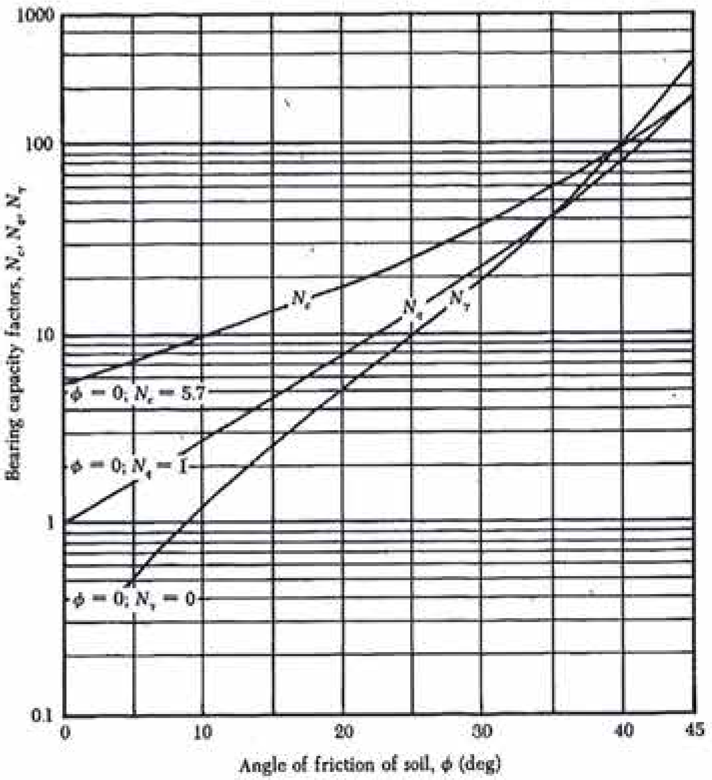

Figure 3.4 Terzaghi's bearing capacity factors for general shear failure—Eq. (3.3)

b. Multi-Layered Subsoils

For this analysis, the multi-layered subsoils within the soil thickness H were converted to a single, homogeneous soil layer having average parameters. The average parameters were weighted based on the thickness of the various soil layers. The parameters γ, c, and ϕ were averaged as follows:

$$\overline{x} = (t_1x_1 + t_2x_2 + \ldots + t_ix_i)/H$$

Where:

$\overline{x}$ = weighted average parameter;
$t_1, t_2, \ldots t_i$ = individual soil layer thicknesses;
$x_1, x_2, \ldots x_i$ = individual soil layer parameter; and,
H = summation of the individual soil layer thicknesses = $(t_1 + t_2 + \ldots + t_i)$.

As a result of this weighted averaging, the soil beneath each landfill cell considered is modeled with single values for thickness (H), unit weight ($\overline{\gamma}$), cohesion ($\bar{c}$), and phi angle ($\overline{\phi}$).

c. Soil Thickness, H

In calculating the weighted average soil parameters, the total soil thickness under consideration must be established. The soils in the region are generally unconsolidated sediments that increase in thickness to more than 8,000 feet at the Atlantic Coastline.

Since this analysis treats the landfill cell as a "foundation", albeit flexible, the Boussinesq and Westergaard analyses of contours of equal vertical stress beneath a foundation on a semi-infinite, homogeneous substrata are chosen to provide guidance on the determination of the variable H. These analyses are presented by Sowers (1979), and consist of portions of the uniform foundation pressure at lateral and vertical locations relative to the center of the foundation, normalized as a function of the foundation width, B. The Boussinesq analysis considers an isotropic elastic solid. The Westergaard analysis considers thinly stratified material.

In theory, the depth an increase in vertical pressure influences is mathematically infinite. However, for purposes of this analysis, a depth where the increase in vertical pressure reduces to 10% of the applied pressure at the ground surface ($0.1q_o$) was considered a limit. The Boussinesq analysis suggests a depth of 2.1B, and the Westergaard analysis suggests a depth of 1.7B. A value of 2B was chosen for this analysis.

The widths of landfill Cells 10 and 13 are approximately 480 feet, and 500 feet, respectively. Depths equal to 2B would be 960 feet and 1,000 feet. The soil borings performed at the site extend vertically to, at most, about 200 feet below the ground surface. Therefore, the soil documented at the bottom of the boring(s) that were chosen to correspond with the bearing capacity points of interest was assumed to extend to the depth 2B.

The overburden pressure, q_o, is defined as:

$$q_o = \gamma D_f$$

Where:

D_f = embedment depth of the foundation (landfill cell); the depth below the surrounding ground elevation of the landfill bottom was used here.

d. Unit Weight Correction for Groundwater Presence

Vesic (1973), and others, prescribe correcting the soil unit weight for the presence of groundwater water at a depth z_w, when $z_w \leq B$. This indeed applies to this analysis. Therefore, effective unit weights were used when calculating the weighted average unit weight. The effective unit weight, γ', is given by:

$$\gamma' = \gamma - \gamma_w$$

Where:

γ = unit weight of soil; and,
γ_w = unit weight of water = 62.4 pcf.

6. Actual Bearing Pressures

Actual bearing pressures, q_{act}, (pressures at the bottom of the landfill) were taken from the settlement analysis. These values were calculated using the Osterberg (1957) nomograph for *Influence Values for Embankment Loading* (Das 1990, and many others). The following table summarizes the actual bearing pressures due to the landfill at the bearing capacity points of interest:

Cell and Point	Applied Bearing Pressure, q_{act} (psf)
Cell 10, Pt 4	8,003 ✓
Cell 13, Pt 3	5,828 ✓

7. Factor of Safety

The minimum factor of safety, FS_{min}, is defined as:

$$FS_{min} = q_u/q_{all}$$

Where:

q_u = ultimate bearing capacity, and,
q_{all} = maximum allowable bearing pressure.

Similarly, the actual factor of safety, FS_{act} is defined as:

$$FS_{act} = q_u/q_{act}$$

Where:

q_{act} = actual bearing pressure.

For this analysis:

$$FS_{act} \geq FS_{min} \qquad \text{and,} \qquad FS_{min} = 3$$

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8. General Analysis Steps

Based on the foregoing, the general analysis steps used are as follows:

a. Select the bearing point(s) of interest, and the associated soil profile(s);
b. Based on the cell dimensions, determine B;
c. Based on B, determine H;
d. Based on the design elevations, calculate Df;
e. Based on the N-value of each soil layer in the soil profile, estimate values for γ, c, and ϕ;
f. Based on the depth to groundwater in the soil profile, and the design elevations of the bottom of the landfill cell, calculate z_w;
g. Correct values if $z_w < B$;
h. Calculate weighted averages based on soil depth for γ, c, and ϕ;
i. Based on ϕ, estimate Nc, Nq, and Nγ;
j. Calculate q_u;
k. From the settlement analysis, determine q_{act}; and,
l. Determine FS_{act}, and confirm $FS_{act} > FS_{min}$.

9. Summary of Calculations

Based on the foregoing, the following table summarizes the bearing capacity-related calculations:

Cell, Pt	Cell 10 Pt 4	Cell 13 Pt 3
B (ft)	480 ✓	500 ✓
D_f (ft)	36	27
H (ft)	960 ✓	1,000 ✓
$\bar{\gamma}$ (pcf)	82.6	144.7
$\bar{c}$ (psf)	7,674	12,335
$\bar{\phi}$ (deg)	0.6	6.4
q_u (psf)	73,134	38,981
q_{act} (psf)	8,003	5,828
FS_{act}	8.1	7.4
FS_{min}	3	3

10. Evaluation and Conclusions

Based on the summary table in Section 9, all of the calculated FS_{act} values are greater than FS_{min}. Therefore, it is concluded that the subsoils beneath the landfill will provide adequate support for bearing.

11. References

1. Terzaghi, Karl, and Peck, Ralph B.; *"Soil Mechanics in Engineering Practice"*; John Wiley & Sons, Inc.; Ed. 2, 1967.

2. Szypcio, Zenon, and Dolzyk, Katarzyna; *"The Bearing Capacity of Layered Subsoil"*; Studia Geotechnica et Mechanica, Vol. XXVIII, No.1 , 2006; ; Wybrzeże Wyspiańskiego 27 Poland.

3. Kumar, Ranjan, *et al*; *"Estimation of Engineering Properties of Soils from Field SPT Using Random Number Generation"*; Indian National Academy of Engineering, 2016; Tables 1 and 3 (p 78 and 79).

4. Das, Braja M.; *"Principles of Foundation Engineering"*; PWS-Kent Publishing Company; Ed. 2, 1990; Fig. 3.4, p 125.

5. Sowers, George F.; *"Introductory Soil Mechanics and Foundations: Geotechnical Engineering"*, 4th Ed., 1979, Macmillan Publishing Co., Inc.; Figures 10.11 and 10.12 (p 457 and 458).

6. Vesic, Aleksander S.; *"Analysis of Ultimate Loads of Shallow Foundations"*; Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers, Vol. 99, No. SM1, January 1973.

7. Project settlement analysis.

8. Project design information.

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a Montrose Environmental Group company

Project:
P.N.: 2018-3854 **Page:** 1 of 2
By: JCA **Date:** 7/12/2020
Checked: **Date:** 7/15/20
Subject: Bearing Analysis - Cell 10, Point 4

Description Analyze the ultimate bearing capacity, and the factor of safety against the actual bearing pressure beneath the landfill.

Soil Profile - Cell 10, Point 4

B = 480 ft *Df* = 36 ft

BOL	*Soil Layer*	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness t, (ft)*	*Average SPR (N_o)*	*Estimated Unit Weight γ (pcf)*	*Unit Weight of Water γ_w (pcf)*	*Estimated Effective Unit Weight γ' (pcf)*	*Estimated Cohesion c (psf)*	*Estimated Phi Angle ϕ (deg)*
GW	1	Sand w/trace fines	116	110	6	37	121.7	0.0	121.7		37.6
	2	Sand w/trace fines	110	101	9	37	121.7	62.4	59.3		37.6
	3	Clay w/trace silt to Clay	101	-844	945	58	145.0	62.4	82.6	7,796	
				Total Depth =	*960*						

Weighted Average γ, c, and ϕ Values for Single Soil Layer

BOL	*Soil Layer*	*Soil Description*	*Unit Weight t x γ*	*Cohesion t x c*	*Phi Angle t x ϕ*
GW	1	Sand w/some silt and clay	730 ✓	0 ✓	225
	2	Sand w/some silt and clay	534 ✓	0 ✓	338
	3	Silt w/some clay	78,057 ✓	7,367,012 ✓	0
		Total Sum	*79,321*	*7,367,012*	*563*

Weighted Average Values for Design

Weighted Average Effective Unit Weight, γ_{av} (pcf) = 82.6 ✓
= (t x γ total sum/total depth)
Weighted Average Cohesion, c_{av} (psf) = 7,674 ✓
= (t x c total sum/total depth)
Weighted Average Phi Angle, ϕ_{av} (deg) = 0.6 ✓
= (t x ϕ total sum/total depth)

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P.N.: 2018-3854 Page: 2 of 2
By: JCA Date: 7/12/2020
Checked: Date: 7/15/20
Subject: Bearing Analysis - Cell 10, Point 4

Bearing Capacity and Factor of Safety

Weighted Average Cohesion, c = 7,674 psf
Bearing Capacity Factor, N_c = 5.9 ✓

Overurden Stress due to Df, $q = \gamma \times Df$ = 2,975 psf
Bearing Capacity Factor, N_q = 1.1 ✓
Weighted Average Effective Unit Weight, γ = 82.6 ✓ pcf

Foundation Width, B = 480 ✓ ft
Bearing Capacity Factor N_γ = 0.16 ✓

Ultimate Bearing Capacity, q_u *(psf) =* 64,670 ✓ psf
$q_u = 1.3cN_c + qN_q + 0.4\gamma BN_\gamma$

Actual Bearing Pressure, q_{act} *(psf) =* 8,003 ✓ psf

Minimum Factor of Safety, FS_{min} = 3 ✓
Actual Factor of Safety, FS_{act} = 8.1 ✓

References

1 Terzaghi, Karl, and Peck, Ralph B.; *"Soil Mechanics in Engineering Practice"*; John Wiley & Sons, Inc.; Ed. 2, 1967.
2 Szypcio, Zenon, and Dolzyk, Katarzyna; *"The Bearing Capacity of Layered Subsoil"*; Studia Geotechnica et Mechanica, Vol. XXVIII, No.1 , 2006; ; Wybrzeże Wyspiańskiego 27 Poland.
3 Kumar, Ranjan, *et al*; *"Estimation of Engineering Properties of Soils from Field SPT Using Random Number Generation"*; Indian National Academy of Engineering, 2016.
4 Das, Braja M.; *"Principles of Foundation Engineering"*; PWS-Kent Publishing Company; Ed. 2, 1990.
5 Sowers, George F.; *"Introductory Soil Mechanics and Foundations: Geotechnical Engineering"*, 4th Ed., 1979, Macmillan Publishing Co., Inc.; Figures 10.11 and 10.12 (p 457 and 458).
6 Vesic, Aleksander S.; *"Analysis of Ultimate Loads of Shallow Foundations"*; Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers, Vol. 99, No. SM1, January 1973.
7 project settlement analysis

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Project:
P.N.: 2018-3854 Page: 1 of 2
By: JCA Date: 7/15/2020
Checked: Date: 7/15/20
Subject: Bearing Analysis - Cell 13, Point 3

Description Analyze the ultimate bearing capacity, and the factor of safety against the actual bearing pressure beneath the landfill.

Soil Profile - Cell 13, Point 3

B = 500 ft *Df =* 7 ft

BOL	Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Unit Weight γ (pcf)	Unit Weight of Water γ_w (pcf)	Estimated Effective Unit Weight γ' (pcf)	Estimated Cohesion c (psf)	Estimated Phi Angle ϕ (deg)
	1	Sand w/silt & clay	90	85	5	5	99.8	0.0	99.8		28.5
	2	Silt w/sand, some gravel	85	81	4	29	138.1	0.0	138.1	3,871	
	3	Clay w/silt lenses	81	79	2	21	128.2	0.0	128.2	2,796	
	4	Sand w/clay lenses	79	75	4	53	145.0	0.0	145.0		42.1
GW	5	Clay w/sand & silt	75	71	4	28	136.5	0.0	136.5	3,737	
	6	Clay w/sand & silt	71	70	1	28	136.5	62.4	74.1	3,737	
	7	Sand w/thin clay layers	70	35	35	81	145.0	62.4	82.6		50.0
	8	Clay w/little silt & trace sand	35	-910	945	97	145.0	62.4	82.6	13,011	

Total Depth = *1000*

Weighted Average γ, c, and ϕ Values for Single Soil Layer

BOL	Soil Layer	Soil Description	Unit Weight t x γ	Cohesion t x c	Phi Angle t x ϕ
	1	Sand w/silt & clay	499.0 ✓	0.0	142.6
	2	Silt w/sand, some gravel	552.6 ✓	15,485.5 ✓	0.0
	3	Clay w/silt lenses	256.5 ✓	5,592.2 ✓	0.0
	4	Sand w/clay lenses	580.0 ✓	0.0	2,230.7
GW	5	Clay w/sand & silt	546.0 ✓	14,947.9 ✓	0.0
	6	Clay w/sand & silt	136.5	3,737.0	0.0
	7	Sand w/thin clay layers	5,075.0	0.0	4,050.4
	8	Clay w/little silt & trace sand	137,025.0	12,295,640.7	0.0
		Total Sum	*144,671*	*12,335,403*	*6,424*

Weighted Average Values for Design

Weighted Average Effective Unit Weight, γ_{av} (pcf) = *= (t x γ total sum/total depth)*	144.7 ✓
Weighted Average Cohesion, c_{av} (psf) = *= (t x c total sum/total depth)*	12,335 ✓
Weighted Average Phi Angle, ϕ_{av} (deg) = *= (t x ϕ total sum/total depth)*	6.4 ✓

Project:
P.N.: 2018-3854 **Page:** 2 of 2
By: JCA **Date:** 7/15/2020
Checked: **Date:** 7/15/20
Subject: Bearing Analysis - Cell 13, Point 3

Bearing Capacity and Factor of Safety

Weighted Average Cohesion, c = 12,335 ✓ psf
Bearing Capacity Factor, N_c = 7.8 ✓

Overurden Stress due to Df, $q = \gamma \times Df$ = 1,013 psf
Bearing Capacity Factor, N_q = 1.9 ✓
Unit Weight, adjusted, γ = 144.7 pcf

Foundation Width, B = 81 ft
Bearing Capacity Factor N_γ = 0.67 ✓

Ultimate Bearing Capacity, q_u (psf) = 37,346 psf
$q_u = 1.3cN_c + qN_q + 0.4\gamma BN_\gamma$

Actual Bearing Pressure, q_{act} (psf) = 5,851 ✓ psf

Minimum Factor of Safety, FS_{min} = 3
Actual Factor of Safety, FS_{act} = 6.4

References
1 Terzaghi, Karl, and Peck, Ralph B.; *"Soil Mechanics in Engineering Practice"*; John Wiley & Sons, Inc.; Ed. 2, 1967.
2 Szypcio, Zenon, and Dolzyk, Katarzyna; *"The Bearing Capacity of Layered Subsoil"*; Studia Geotechnica et Mechanica, Vol. XXVIII, No.1 , 2006; ; Wybrzeże Wyspiańskiego 27 Poland.
3 Kumar, Ranjan, *et al*; *"Estimation of Engineering Properties of Soils from Field SPT Using Random Number Generation"*; Indian National Academy of Engineering, 2016.
4 Das, Braja M.; *"Principles of Foundation Engineering"*; PWS-Kent Publishing Company; Ed. 2, 1990.
5 Sowers, George F.; *"Introductory Soil Mechanics and Foundations: Geotechnical Engineering"*, 4th Ed., 1979, Macmillan Publishing Co., Inc.; Figures 10.11 and 10.12 (p 457 and 458).
6 Vesic, Aleksander S.; *"Analysis of Ultimate Loads of Shallow Foundations"*; Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers, Vol. 99, No. SM1, January 1973.
7 project settlement analysis
8 project drawings, and geotechnical data

REFERENCE 7 1/5

GENERAL SOIL PROFILE: CELL 10 **, POINT** 4

(NOT TO SCALE)

General Existing Profile (elev)	General Final Profile (elev)
	270 (Top of landfill)
Boring Profile: B-30	2' cap 144' CDD Waste 6' Liner & Leachate collection system 118 (Floor of landfill)
TOG 116	2' fill Navg=40
Sand w/ trace fines Navg= 37 101	∇ 110
clay w/ trace silt to clay Navg=58 56	

REFERENCE 7 2/5

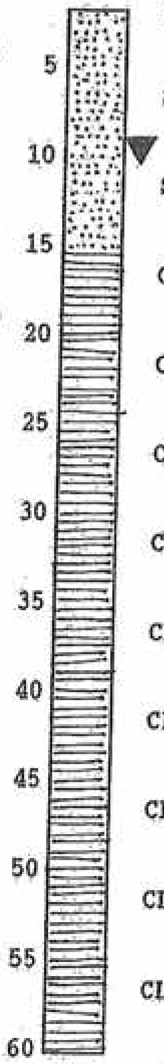
GS EL. 116±

BORING NUMBER: B-30

DATE INSTALLED: 4-25-91
PROJECT: CHESAPEAKE RUBBLE FILL
SAMPLE METHOD: SPLIT SPOON
LOGGED BY: MARK SCHULTZ
DRILLING METHOD: HOLLOW STEM AUGER AND MUD
DRILLER: HARDIN-HUBER, INC

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches) ↓ (N)	Description
1	0 - 2	2-3-4-5 ⑦ (10)	SAND, med, little fn, tr clay, yellow-brown, moist
2	5 - 7 Navg=37	15-23-25-30 ㊽ (15)	SAND, as above
3	10-12	9-24-32-30 (56) (24)	SAND, med, little fn and little clay, yellow-brown, wet[a]
4	15-17	11-17-23-28 ㊵ (22)	CLAY, tr silt, red, moist
5	20-22	10-18-22-26 ㊵ (24)	CLAY, tr silt, gray-purple, moist
6	25-27	9-15-22-30 ㊲ (24)	CLAY, tr silt, red-gray, moist
7	30-32 Navg=58	15-17-19-28 ㊱ (24)	CLAY, tr silt, gray w/red, moist
8	35-37	10-14-18-20 ㉜ (20)	CLAY, tr silt, red w/gray mottles, slightly moist
9	40-42	30-45-70 (100+) (18)	CLAY (no silt), gray w/red mottles, slightly moist
10	45-47	50-60-65 (100+) (18)	CLAY, brown-red, slightly moist
11	50-52	14-35-45-51/5 (80) (18)	CLAY, brown, slightly moist
12	55-57	8-20-35-45 (55) (20)	CLAY, brown w/red,, slight to tr moist

Graphic Log



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a. Rods wet at 10 feet.

REFERENCE 7 3/5

(NOT TO SCALE)

GENERAL SOIL PROFILE: CELL 13**, POINT** 3

General Existing Profile (elev)

Boring Profile: B-12

95

clay, silt & clay w/sand Navg=11

90

Sand w/some silt & clay Navg=39

85

Sand w/silt & clay Navg=18

73

Sand w/silt & few thin clay layers Navg=

52

Clay w/some sand Navg=

23

Clay & silt w/sand Navg=

15

General Final Profile (elev)

202 Top of landfill

2' Cap

100' CDD Waste

6' Liner & Leachate Collection System

94 Floor of landfill

▽ 72

REFERENCE 7 4/5

TOP OF GROUND ≃ 97.0

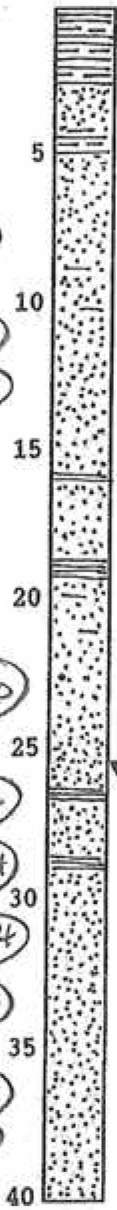
BORING NUMBER: B-12

MONITOR WELLS: MW-4

DATE INSTALLED: 7-22-89
PROJECT: CHESAPEAKE RUBBLE FILL
SAMPLE METHOD: SPLIT SPOON DRILLING METHOD: HOLLOW STEM AUGER and MUD
LOGGED BY: GREG ADAMSON DRILLER: HARDIN-HUBER, INC

Ⓝ

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	Graphic Log	Description
1	0 - 2	3-3-4-6 ⑦ (16)		CLAY, little silt and sand, red-br-yellow
2	2.5-4.5	3-7-9-11 ⑯ (21)		16" SAND, fn & vf, tr silt & clay, rd-br-yellow 5" SILT and CLAY, little sand, yellow-red
3	5' 5 - 7	㊳ 9-19-19-30 (17)		SAND, med, some fn, tr silt and clay, red-brown-lt tan
4	7.5-9.5	6-18-21-26 ㊵ (20)		8" SAND, as above 12" SAND, fn to vf, some silt, tr clay, lt tan-red-brown
5	10' 10-12	7-13-13-16 ㉖ (19)		SAND, med, some fn, tr silt, lt tan-red-brown
6	12.5-14.5	6-10-11-13 ㉑ (21)		SAND, fn and vf, little med, tr silt and clay, lt tan-red-brown
7	15-17	3-3-5-3 ⑧ (20)		SAND, as above, gray and red-brown, with 2" clay layer
8	17.5-19.5	3-5-11-24 ⑯ (18)		5" SAND, as above 13" CLAY, some silt, tr sand, gray
9	20-22 22'	3-5-16-24 ㉑ (17)		SAND, med, some fn, some silt and clay stringers, gray-red-brown-yellow
10	22.5-24.5	30-33-27-18 (60) (17)		8" GRAVEL, some sand, tr silt, red-brown 9" SAND, fn to vf, tr silt & clay, red-br-gray ▽
11	25-27	5-20-41-51/5" (24) (92)	▼	6" SAND, as above 6" CLAY, ltl silt, thin sand lenses, gray 8" SAND, med-fn, gray-rd-br, <u>saturated</u>
12	27.5-29.5	20-24-30-38 (54) (20)		10" CLAY, ltl sand and silt, gray-rd-br 10" SAND, med, ltl fn, tr silt & clay, gray
13	30-32	22-28-36-40 (64) (20)		SAND, as above, saturated
14	32.5-34.5	27-38-43-51 (81) (24)		SAND, as above
15	35-37	33-51/6" (100) (12)		SAND, as above
16	37.5-39.5	15-51/6" (100) (12)		SAND, as above

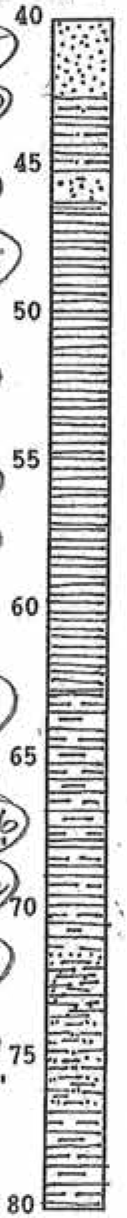


REFERENCE 7
5/5

BORING NUMBER: B-12 continued

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	Description
17	40-42	4-14-51/5" (65) (8)	SAND, as above
18	43' 42.5-44.5	45-51/3" (100) (8)	CLAY, little silt and sand, with thin sand lenses, mottled red-gray
19	45-47	14-45-48 (93) (18)	11" SAND, med and coarse, tr silt & clay, gray 7" CLAY, tr silt and sand, dense, gray
20	47.5-49.5	35-47-51/4" (98) (16)	CLAY, as above
21	50-52	33-51/4" (100) (0)	No recovery - drilled like clay
22	52.5-54.5	29-51/6" (100) (12)	CLAY, as above, mottled gray-red-br-purple
23	55-57	43-51/5" (100) (11)	CLAY, as above
24	57.5-59.5	34-51/5" (100) (0)	No recovery, drilled like clay
25	60-62	36-51/5" (100) (11)	CLAY, as above
26	62.5-64.5	41-33-42-47 (75) (21)	6" CLAY, as above 15" CLAY and SILT, little sand, gray
27	65-67	45-51/5" (100) (0)	No recovery
28	67.5-69.5	37-45-47-51/5" (96) (15)	CLAY, some silt, tr sand, red-br-gray
29	70-72 72'	19-29-33-42 (62) (21)	10" CLAY, as above 5" CLAY & SILT, tr sand, mottled red-br-gray 6" SAND, vf, some silt, tr clay, gray
30	72.5-74.5	10-27-36-49 (63) (0)	No recovery
31	75-77	19-29-38-51/5" (67) (21)	7" SILT & vf SAND, tr clay, mott rd-br-gray 14" SILT & CLAY, little vf sand, red-br-gray
32	77.5-79.5	21-28-51/5" (79) (17)	SILT and CLAY, as above

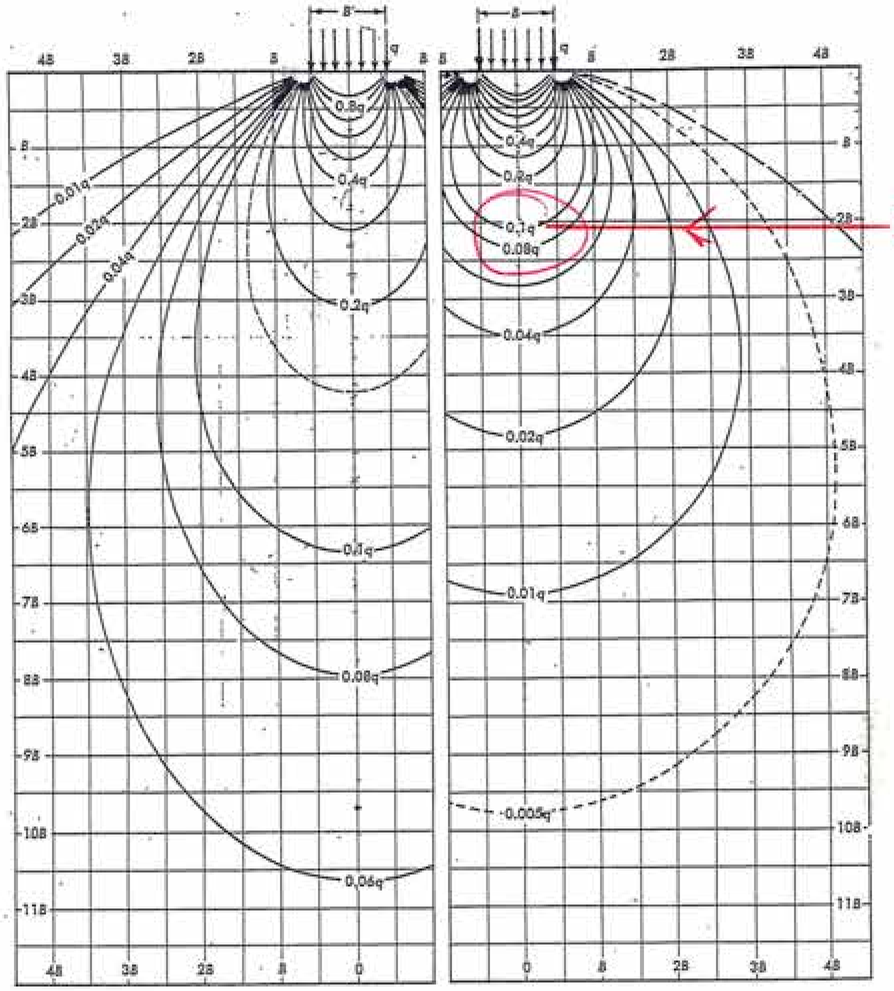
Graphic Log



Groundwater on the drill rods at 34 feet.

REFERENCE 5 1/1

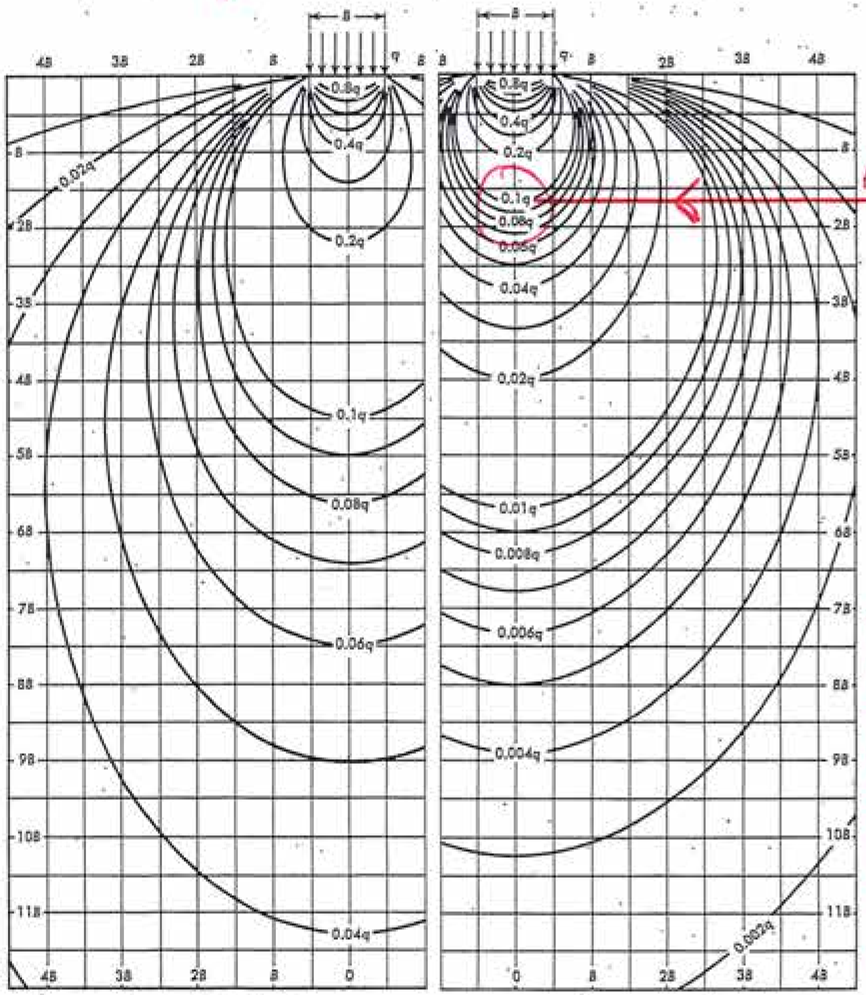
* USE depth = 2B for q = 0.1q₀ *



a. Infinitely long foundation

b. Square foundation

Figure 10.11 *Contours of equal vertical stress beneath a foundation on a semiinfinite, homogeneous, isotropic elastic solid—the Boussinesq analysis. Stresses are given as proportions of the uniform foundation pressure, q; distances and depths in terms of the foundation width, B.*



a. Infinitely long foundation

b. Square foundation

Figure 10.12 *Contours of equal vertical stress beneath a foundation on a semiinfinite, homogeneous, thinly stratified material—the Westergaard analysis. Stresses are given as proportions of the uniform surface pressure, q; distances and depths in terms of the foundation width, B.*

REFERENCE 4

1/1

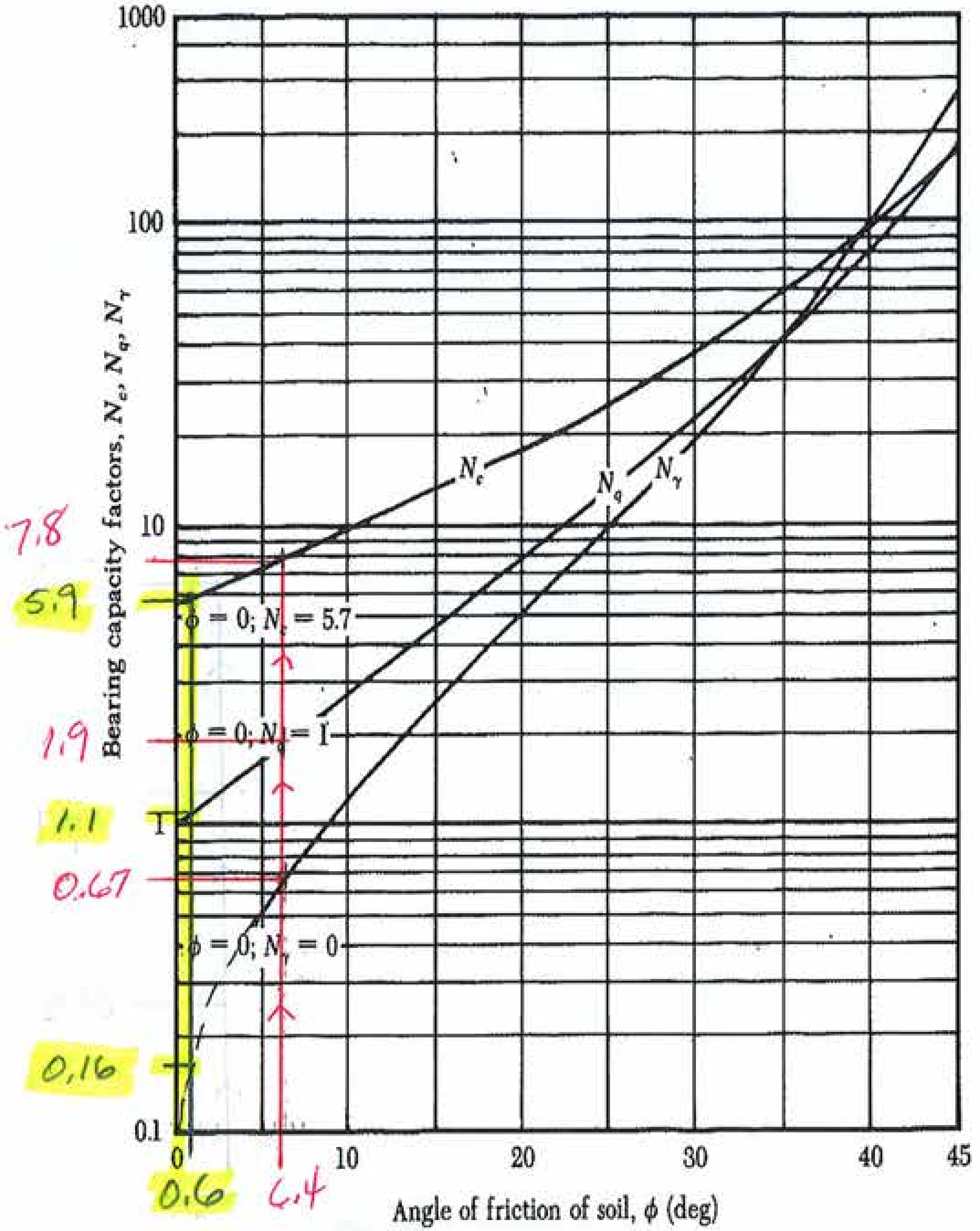


Figure 3.4 Terzaghi's bearing capacity factors for general shear failure—Eq. (3.3)

ATTACHMENT 9F

Settlement

Reviewed by PGS 09/01/2021

ADVANCED GeoServices a Montrose Environmental Group company	Subject: Differential Settlement Analysis		
	Job No. 2018-3854	Made by: JCA	Date 07/16/20
	Ref.	Checked by: VEF	Sheet 1 of 17

Note: The revised design included lowering the maximum top of landfill elevations by from approximatly 272 ft to 226 ft, and reducing the top of cap side slopes from 3:1 to 4:1. As a result, these calculations over estimate the differential settlement and are considered more conservative.

Therefore these calculations are not being revised and the construction design slopes for the bottom of the landfill should still be constructed with 3% slopes

1. Purpose

The purpose of this analysis is to estimate the settlement of the constructed landfill due to consolidation of the underlying soils. Total and differential settlements are considered.

2. Analysis Approach

Settlement is commonly considered in design where structural foundation loads are expected to cause relative immediate and long-term consolidation of underlying compressible soils. Elastic (immediate) settlement occurs due to the rearrangement of soil particles due to the applied load, and is considered a relatively "immediate" response to an applied load. Consolidation settlement occurs over a longer period of time, and is due to the progressive relieving of pore water pressure and the reduction of void space. Elastic theory is applied to both cohesive and non-cohesive soils. Consolidation theory is applied only to cohesive soils.

In general, this analysis uses site-specific data and published empirical formulas to extrapolate soil characteristics across the site. Empirical formulas were modified slightly to more closely approximate site-specific soil characteristics. Two landfill cells were chosen for analysis - Cells 10 and 13. These cells have the greatest waste depth in each of the two waste disposal areas.

3. Laboratory Consolidation Tests

Three, one-dimensional consolidation tests were performed on relatively undisturbed samples of on-site clay soils. One sample was obtained from an area near boring MW-28 where the targeted clay soil was exposed at the ground surface due to past mining excavation. Two samples were obtained from clay soil layers in borings PMW-13 and PMW-23.

a. Discussion of Laboratory Consolidation Tests

1. Boring MW-28: This sample was cut from the clay soil exposed at the ground surface near MW-28. A bulk block sample was cut at a depth of approximately 2 to 4 feet below the ground surface. Due to the past surface mining activities in the area of MW-28, it is believed the clay layer sampled just at the ground surface was once at a similar depth below the ground surface as that occurring in Boring PMW-23. The soil exhibited the following characteristics:

   a. Void ratio = 0.499;
   b. Unit weight = 136.8 pcf; and,
   c. Standard Penetration Test (SPT) N-value (presumed from Boring MW-28) = 30.

   From the *e-log p* curve developed from the test data, and using Cassagrande's graphical method (Holtz and Kovacs), the approximate likely effective pre-consolidation stress, α_p', was estimated to be 10.8 ksf. Additionally, the Compression Index (C_C) and Recompression Index (C_R), were estimated to be 0.039, and 0.028, respectively.

Based on a correlation of unit weight and N-value for cohesive soils (Terzaghi and Peck, University of Massachusetts, Sowers, others), an estimated unit weight of 139.9 pcf is suggested. This compares closely to the laboratory-measured unit weight of 136.8 pcf. See section 4.a for a discussion of relationship between N-value and soil unit weight.

2. Boring PMW-13: This sample was obtained in a clay layer at a depth of approximately 105' to 107' below the ground surface, and exhibited the following characteristics:

a. Void ratio = 0.795; and,
b. Unit weight = 125.1 pcf.

From the *e-log p* curve developed from the test data, and using Cassagrande's graphical method (Holtz and Kovacs), the approximate likely effective pre-consolidation stress was determined to be 9.5 ksf. Additionally, the Compression Index (C_C) and Recompression Index (C_R), were estimated to be 0.204, and 0.032, respectively.

Some inconsistencies were noted when comparing the field data, the laboratory data, and the suggested values from the N-value correlation, as follows:

a. SPT N-values of 58 and 46 were observed in Boring PMW-13 just above and below the sample depth. Based on a published correlation of unit weight and N-value for cohesive soils, estimated unit weights well in excess of 140+ pcf are suggested. This does not compare well with the laboratory-measured unit weight of 125.1 pcf.
b. Based on the N-value correlation and the laboratory unit weight of 125 pcf, an N-value of approximately 18 is suggested. This does not compare well with the N-values observed just above and below the sample of 58 and 46, respectively.
c. Based on the N-value correlation, the qualitative description of the consistency of cohesive soils having N-values of 46 and greater is "hard". A qualitative description of "very stiff" corresponds to an N-value of 18. However, the qualitative description of the sample consistency from the laboratory test is "soft (thumb will penetrate)".

Although field data and laboratory data are not expected to exactly match various empirical correlations, the magnitude of these inconsistencies suggest the sample tested was not representative of the targeted soil. Therefore, the PMW-13 test results were set aside, and not used in this analysis.

3. Boring PMW-23: This sample was obtained in a clay layer at a depth of approximately 128' to 130' below the ground surface, and exhibited the following characteristics:

   a. Void ratio = 0.574;
   b. Unit weight = 134.5 pcf; and,
   c. SPT N-Value = 27.

   From the *e-log p* curve developed from the test data, and using Cassagrande's graphical method (Holtz and Kovacs), the approximate likely effective pre-consolidation pressure, α_p', was determined to be 11.0 ksf. This is consistent with the value estimated for the sample tested from the ground surface near MW-28. Additionally, the Compression Index (C_C) and Recompression Index (C_R), were estimated to be 0.211, and 0.073, respectively.

   Based on a correlation of unit weight and N-value for cohesive soils, an estimated unit weight of 135.0 pcf is suggested. This compares very closely with the laboratory-measured unit weight of 134.5 pcf.

b. Overconsolidation Ratio

The Overconsolidation Ratio, OCR, is defined as the ratio of the estimated pre-consolidation stress to the estimated existing effective vertical stress, α_p'/α_{vo}' (Holtz and Kovacs). Soils that have OCR=1 are considered "normally consolidated" – that is, the existing vertical effective stress is the greatest stress the soil has ever experienced. Soils that have OCR >1 are considered "overconsolidated" – that is, the existing vertical effective stress is less than the greatest stress the soil has ever experienced.

Using the boring data, and the N-value correlation, the MW-28 soil profile suggests the existing vertical effective stress, α_{vo}', at that sample location is 274 psf. The overconsolidation ratio, OCR, is calculated to be (10,800/274) = 39.4. Similarly, using the boring data, and the N-value correlation, the soil PMW-23 soil profile suggests the existing vertical effective stress, α_{vo}', at that sample location is 14,910 psf. The overconsolidation ratio, OCR, is calculated to be (11,000/14,910) = 0.7.

"... it is not impossible to find a soil that has an OCR < 1, in which case the soil would be ***underconsolidated****. Underconsolidation can occur, for example, in soils that have only recently been deposited, either geologically or by man. Under these conditions, the clay layer has not yet come to equilibrium under the weight of the overburden load."*

Holtz and Kovacs, page 294

Recent geologic deposition and resulting underconsolidation is implied by the description of the soils in the Atlantic Coastal Plain Province by the Maryland Geological Survey, as follows:

> *"The Atlantic Coastal Plain Province is underlain by a wedge of unconsolidated sediments including gravel, sand, silt, and clay, which overlaps the rocks of the eastern Piedmont along an irregular line of contact known as the Fall Zone. Eastward, this wedge of sediments thickens to more than 8,000 feet at the Atlantic coast line."* (see http://www.mgs.md.gov/geology/)

Additionally, it is common knowledge that the property has been mined for sand and gravel in the past. Therefore, much earthwork has occurred which could very well have resulted in some soils experiencing an *underconsolidated* condition.

4. Correlation of Soil Properties

Various correlations of soil properties are used to extrapolate known site-specific data to soils across the site. The following sections describe the various correlations, and, if applicable, how they were modified for this analysis.

a. Standard Penetration Test Resistance and Unit Weight

The correlation between the Standard Penetration Test Resistance (N) and soil consistency was first given by Terzaghi and Peck (1948). Many geotechnical engineering texts have referenced this correlation, and have expanded on it by adding unit weight and other parameters. In general, each consistency category has a range of suggested N-values and a range of suggested unit weights. Some of the range of suggested unit weights "overlap" between consistency categories. Therefore, for this analysis, the correlation provided by the University of Massachusetts at Lowell (Ref. 6) was modified slightly so that each consistency category has a unique range of suggested soil unit weights. This correlation was modified to be defined as follows:

Description	**N-Value**	**Unit Weight (pcf)**
Non-Cohesive Soils – Relative Density		
Very Loose	0 – 4	90 - 95
Loose	5 – 10	96 – 105
Firm	11 – 20	106 – 110
Medium Dense	21 – 30	111 - 115
Dense	31 – 50	116 – 140
Very Dense	50+	140+
Cohesive Soils – Consistency		
Very Soft	0 – 2	90 – 100
Soft	3 – 4	101 – 105
Firm	5 – 8	106 - 110
Stiff	9 – 15	111 - 125
Very Stiff	16 – 30	126 – 140
Hard	30+	140+

This correlation was used to develop the following equations to calculate soil unit weight based on N-value:

$$\text{Non-Cohesive Soils:}\quad \gamma_s = 0.001N^3 - 0.0695N^2 + 2.0802N + 89.265$$

$$\text{Cohesive Soils:}\quad \gamma_s = 0.0027N^3 - 0.1536N^2 + 3.8139N + 90.869$$

The specific gravity, G_s, of soil is given by $G_s = \gamma_s/\gamma_w$, where γ_w is the unit weight of water (62.4 pcf). The soil unit weight, γ_s, can then be defined as:

$$\gamma_s = G_s(\gamma_w)$$

The laboratory consolidation test data indicate G_s values of 2.65 and 2.80 were assumed for non-cohesive and cohesive soils, respectively. These are indeed typical values.

The soil unit weight calculated using G_s is a "solid volume" unit weight - that is, the unit weight of soil <u>with zero air voids</u>. For non-cohesive soils, the solid volume unit weight is (2.65)(62.4)=165.4 pcf. Similarly, for cohesive soils, the solid volume unit weight is (2.80)(62.4)=174.7 pcf.

It is recognized these unit weights are not likely to exist for soil. However, there are many N-values from the standard penetration tests that would result in values of unit weights even greater than these if used in this 3rd order polynomial correlation. Noting that the upper value of unit weight from the N-value is designated as "140+", the unit weights calculated in this analysis from the N-value formulas were set to maximum values of 145.0 pcf for all soils.

b. Unit Weight and Void Ratio

Soils are presumed saturated for this analysis. The void ratio, e, is given by Das (1990):

$$e \;=\; (G_s(\gamma_w) - \gamma_s) \,/\, (\gamma_s - \gamma_w)$$

Considering the boring MW-28 data, a G_s value of 2.80, and a γ_s of 136.8, an e value of 0.510 is calculated. The actual void ratio, e_o, of this sample was 0.499. Similarly, using the boring PMW-23 data, a G_s value of 2.80, and a γ_s of 134.5, an e value of 0.558 is calculated. The actual void ratio, e_o, of this sample is 0.574. The e value of soils in this analysis is calculated from this equation, based on soil unit weight.

c. Void Ratio and Coefficient of Compression

As indicated in Section 3.a, the soil samples used in the laboratory consolidation tests exhibited the following characteristics:

1. MW-28 (N=27, depth = 2'-4', OCR=39.4):
   Void ratio = 0.499
   Compression Index, $C_C = 0.039$

2. PMW-23 (N=30, depth = 128'-130', OCR=0.7)
   Void ratio = 0.574
   Compression Index, $C_C = 0.211$

Several empirical formulas (Al-Khafaji, *et al*) were compared to this laboratory data to assess the correlation between void ratio and compression index, as follows:

Equation	Applicability	Reference
$C_c = 0.40(e_o - 0.25)$	All natural soils	Azzouz *et al.* 1976
$C_c = 1.15(e_o - 0.35)$	All clays	Nishida 1956 (a)
$C_c = 0.54(e_o - 0.35)$	All natural soils	Nishida 1956 (b)
$C_c = 0.75(e_o - 0.50)$	Soils of very low plasticity	Sowers 1970
$C_c = 0.156e_o + 0.0107$	All clays	Bowles 1989

Sample	Void Ratio	Cc Lab	Cc Azzouz 1976	Cc Nishida (a) 1956	Cc Nishida (b) 1956	Cc Sowers 1970	Cc Bowles 1989
MW-28	0.499	0.039	0.100	0.171	0.080	-0.001	0.588
PMW-23	0.574	0.211	0.130	0.258	0.121	0.056	0.674

This comparison indicates the Nishida (b) 1956 formula gives the closest calculated value based on void ratio for the overconsolidated sample (MW-28). Similarly, the Nishida (a) 1956 formula gives the closest calculated value based on void ratio for the underconsolidated sample (PMW-23). The only mathematical difference in the two Nishida equations is the multiplier of 1.15 or 0.54. This analysis used an average multiplier of 0.875, so that the void ratio to compression index is given as:

$$C_C = 0.875(e_o - 0.35)$$

Note that as void ratio decreases, C_C also decreases. It is mathematically possible the calculated C_C value could be equal to or less than zero. In this instance, the soil layer will be interpreted as being incompressible.

d. Coefficient of Compression and Coefficient of Recompression

As indicated in Section 3.a, the soil samples used in the laboratory consolidation tests exhibited the following characteristics:

1. MW-28 (N=27, depth = 2'-4', OCR = 39.4)
   Compression Index, $C_C = 0.039$
   Recompression Index, $C_R = 0.028$

2. PMW-23 (N=30, depth = 128'-130', OCR = 0.7)
   Compression Index, $C_C = 0.211$
   Recompression Index, $C_R = 0.073$

The recompression index, C_R, is compared to the compression index, C_C, to assess the correlation between them. For the overconsolidated sample (MW-28), the ratio of C_C to C_R is given as (0.039/0.028) = 1.39. Similarly, for the underconsolidated sample (PMW-23), the ratio of C_C to C_R is given as (0.211/0.073) = 2.89. For this analysis, an average value of 2.14 was used so that the C_C to C_R ratio is written as:

$$C_C/2.14 = C_R = 0.47C_C$$

It is noted that when C_C is equal to or less than zero C_R is also equal to or less than zero. In this instance, the soil layer will be interpreted as being incompressible.

e. Summary of Soil Property Correlations

Based on the foregoing, the formulas used to estimate soil characteristics for this settlement analysis are as follows:

Non-Cohesive Soils:
$\gamma_s = 0.001N^3 - 0.0695N^2 + 2.0802N + 89.265$
$G_S = 2.65$ $\gamma_{smax} = 145$ pcf

Cohesive Soils:
$\gamma_s = 0.0027N^3 - 0.1536N^2 + 3.8139N + 90.869$
$G_S = 2.80$ $\gamma_{smax} = 145$ pcf
$C_C = 0.875(e_o - 0.35)$
$C_R = 0.47C_C$

5. Settlement Locations and Points of Interest

a. Locations - Cells

The landfill comprises 20 disposal cells. Cells 10 and 13 were chosen for the settlement analysis.

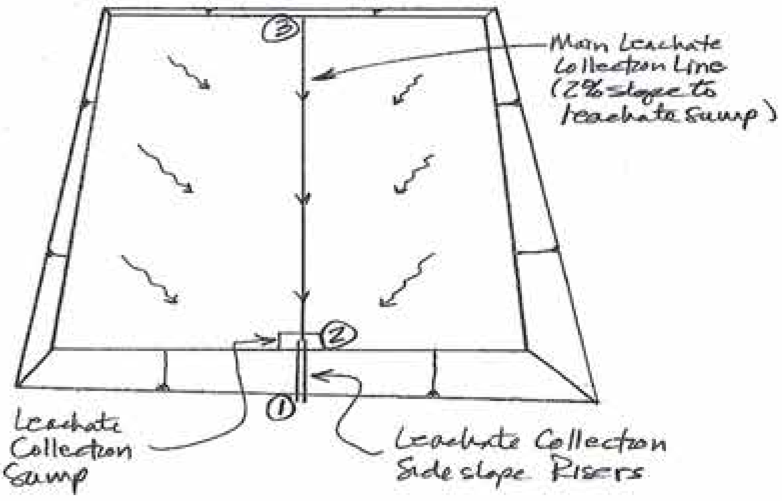
These cells have the greatest waste thickness in each of the west and east landfill areas, respectively.

b. Points of Interest

The settlement points of interest are located at three to four places in each cell:

1. Top of ground at the landfill edge;
2. Toe of interior slope at the leachate collection sump;
3. Highest point along the main leachate collection line in the cell; and,
4. An additional location if the point of greatest waste thickness is not located over Point 3.

Total and differential settlement are calculated and evaluated for the impact they may have on the constructed facility. As an example, the following schematic shows the general location of these points of interest.



c. Soil Profiles

For each settlement point of interest, an existing boring was chosen to represent the underlying soil profile. In some cases, settlement points of interest shared the same soil profile due to the proximity to each other.

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The following is a list of the borings chosen for each settlement point of interest:

Cell / Point	Boring	Cell / Point	Boring
10/1	B-105	13/1	B-13
10/2	B-105	13/2	B-13
10/3	B-104/MW-18	13/3	B-12
10/4	B-30		

Each boring generally had many soil layers identified from the field activities. For the purpose of this analysis, the soil layers in each boring were grouped to reduce the number of layers needed for analysis. For each layer group, a general description was chosen, and the N-values were averaged. This allowed the grouped layers to be modeled with a total layer thickness, average N-value, and average unit weight.

d. Effective Pre-consolidation Stress

Since the soils are generally and broadly considered to be underconsolidated, and recent mining activities have likely changed the vertical stresses across most of the site, this analysis assumes the existing conditions are "normally consolidated". This sets the estimated existing effective vertical stresses as the effective pre-consolidation stresses.

6. Load Application

The loads applied are structural fill and the construction demolition and debris (CDD) waste.

a. Structural Fill

In some areas, structural fill is needed to achieve the desired final grades. For the purposes of this analysis, this was incorporated as an additional soil layer in the soil profile with an N-value of 40, and a unit weight of 145 pcf. The effect of the applied load, however, is taken into account in the settlement calculations.

b. CDD Waste

The landfilling of the CDD waste is modeled as an embankment fill. The effect on the underlying soil profile was modeled using the Osterberg 1957 (Das) nomograph for *Influence Values for Embankment Loading*. The following figures depict the Osterberg nomograph and the embankment loading diagram.

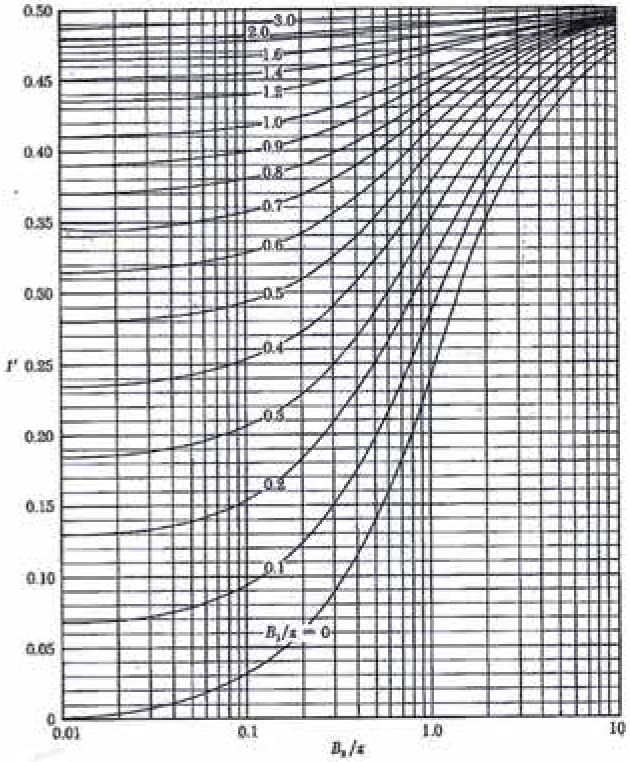

Figure 3.40 Influence value of I' for embankment loading (after Osterberg, 1957)

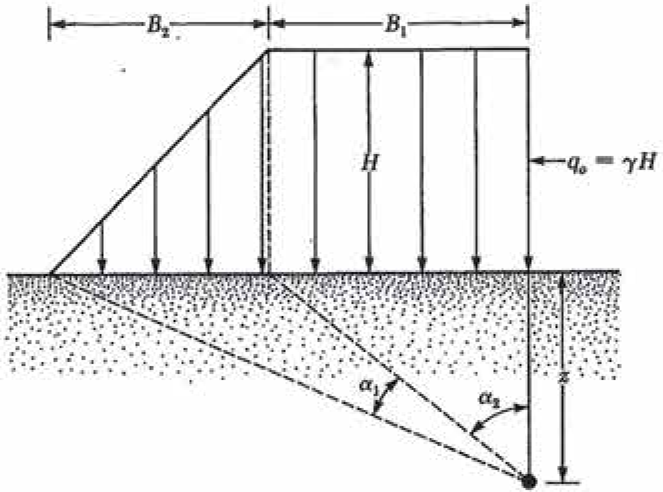

Figure 3.39 Embankment loading

In the nomograph, the I' value is a function of B_1/z and B_2/z, and the increase in vertical stress is given by $p_o = q_o I'$. Das (1990) provides equations for using the Osterberg nomograph that allow the efficient use of a spreadsheet for repetitive calculations, as follows:

$$\boxed{\Delta p = \frac{q_o}{\pi}\left[\left(\frac{B_1 + B_2}{B_2}\right)(\alpha_1 + \alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right]} \qquad (3.97)$$

where $q = \gamma H$

γ = unit weight of the embankment soil

H = height of the embankment

$$\alpha_1 \text{ (radians)} = \tan^{-1}\left(\frac{B_1 + B_2}{z}\right) - \tan^{-1}\left(\frac{B_1}{z}\right) \qquad (3.98)$$

$$\alpha_2 = \tan^{-1}\left(\frac{B_1}{z}\right) \qquad (3.99)$$

Since the original Osterberg nomograph is a semi-log relationship, Das' equations require B_1 and B_2 to be greater than zero. Therefore, for instances where these values are indeed equal to zero, a value of 0.01 was used.

c. Landfill Components

Landfill Component	Value
Cap and Cover Soil Thickness (ft)	3
Unit Weight, γ (pcf)	115
CDD Waste Unit Waste Thickness (ft)	varies
CDD Waste Unit Weight, γ (pcf)	48.7
Protective Cover Layer Thickness (ft)	4
Unit Weight, γ (pcf)	115
Leachate Collection Layer Thickness (ft)	2
Unit Weight, γ (pcf)	115

7. Settlement Calculations

As indicated in Section 2, elastic (immediate) settlement occurs due to the rearrangement of soil particles due to the applied load, and is considered a relatively "immediate" response to an applied load. Consolidation settlement occurs over a longer period of time, and is due to the progressive relieving of pore water pressure and the reduction of void space. The analysis approach is to use elastic theory for both non-cohesive soils and cohesive soils, and consolidation theory for cohesive soils.

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a. Elastic Settlement

Elastic settlement is calculated by (Bowles):

$$S = H_o(\Delta\sigma_v)/E_s$$

Where:

S = settlement (ft);
H_o = initial height or thickness of soil layer (ft);
$\Delta\sigma_v$ = Change in vertical stress (ksf); and,
Es = Young's modulus of elasticity (ksf).

From Das (1990) after Schmertmann (1970), E_s for sand is defined as:

$$E_s = 8N \text{ (tsf)} \qquad \text{or} \qquad E_s = 16N \text{ (ksf)}$$

Where:

N = standard penetration resistance N-value;
tsf = tons per ft^2;
ksf = kips per ft^2; and,
kips = units of 1,000 lbs.

Das (1990) additionally defines E_S for clays as:

	Used here:
Normally consolidated: E_S = 250c to 500c	Average = 375c
Overconsolidated: E_S = 750c to 1,000c	Average = 875c

Where:

c = undrained cohesion of clayey soil (psf).

The undrained cohesion, c, is calculated as half of the unconfined compression, q_u (Terzaghi and Peck, 1967). Terzaghi also provides a relationship between N and q_u, as follows:

Art. 45 *Program for Subsoil Exploration* 347

Table 45.2
Relation of Consistency of Clay, Number of Blows N on Sampling Spoon, and Unconfined Compressive Strength

	q_u in tons/ ft²					
Consistency	Very Soft	Soft	Medium	Stiff	Very Stiff	Hard
N	<2	2–4	4–8	8–15	15–30	>30
q_u	<0.25	0.25–0.50	0.50–1.00	1.00–2.00	2.00–4.00	>4.00

This data was used to develop an equation to calculate q_u based on N for clayey soils, as follows:

$$q_u = 2(0.0053N^2 + 0.0458N + 0.2031) \quad \text{(ksf)}$$

b. Consolidation Settlement

Consider the following:

α_p' = effective pre-consolidation stress;
α_{vo}' = effective existing or initial vertical stress; and,
α_{vf}' = effective final vertical effective stress.

Consolidation settlement is calculated by (Holtz and Kovacs):

$$S = C_R'H_o(\log(\sigma_p'/\sigma_{vo}') + C_C'H_o(\log(\sigma_{vf}'/\sigma_p')$$

Where:

S = settlement;
C_R' = corrected coefficient of recompression = $C_R/(1+e_o)$;
H_o = initial height or thickness of the soil layer;
σ_p' = effective vertical preconsolidation stress;
σ_{vo}' = effective initial or interim vertical stress, as appropriate;
C_C' = corrected coefficient of compression = $C_C/(1+e_o)$; and,
σ_{vf}' = effective final vertical stress.

Note:

1. In cases of only recompression where $\sigma_{vf}' < \sigma_p'$, σ_{vf}' is substituted for σ_p' in the $C_R{}'$ term, and the $C_C{}'$ term = 0; and,
2. In cases where excavation is proposed prior to landfill construction, the σ_p' value is determined prior to the excavation, and the σ_{vo}' value is determined after the excavation.

c. General Analysis Steps

The general analysis steps are:

1. Determine which cells and points of interest are to be analyzed;
2. At each point of interest, determine the boring that is used for the soil profile;
3. Generalize the soil profile at each point of interest to minimize the number of soil layers needed for analysis;
4. As discussed in the settlement analysis, to establish the soil depth to which this analysis considers, extend the generalized soil profile to a depth equal to twice the width of the cell;
5. Average the N-values for the soil layers, and determine the unit weigh of each soil layer;
6. Determine the initial effective vertical stress and the effective preconsolidation stress at the center of each soil layer, taking into account the groundwater elevation;
7. Establish an interim soil profile, if needed, to account for the addition of structural fill, or the excavation of soils to the desired grades for landfilling, and determine interim effective vertical stresses;
8. Determine the applied loads for the soil profile and the landfill cross-section at each point of interest;
9. Determine the final effective vertical stress for each soil layer after the landfill loads are applied;
10. Using the elastic settlement formula, calculate the estimated settlement for each soil layer;
11. Using the consolidation settlement formula(s), calculate the estimated settlement for each cohesive soil layer;
12. Sum the estimated settlement values for each soil layer at each point of interest;
13. Calculate the differential settlement between points of interest;
14. Evaluate the effect of the differential settlement between points of interest; and,
15. Determine if changes in the design are needed to account for the estimated differential settlements.

Reviewed by PGS 09/01/2021

d. Calculation Results

The attachments provide a detail presentation of the calculations described. A summary follows:

Cell 10 Settlement	
Point	Calculated Settlement (in)
1	1.72
2	2.32
4	20.13
3	13.18

Cell 13 Settlement	
Point	Calculated Settlement (in)
1	0.78
2	1.14
3	14.29

8. Evaluation and Conclusions

Distances and elevations were scaled and estimated from the design drawings. Inherent to that is some effect of rounding. This is noted for the initial slope values calculated for both cells between Points 1 and 2. Although these slopes were designed to be 33% (3H to 1V), the slope calculated here is slightly different. This has no impact on the evaluation since the difference between initial slope and final slope is the focus.

a. Cell 10 Evaluation

Variable	Point 1	≫ ↓ ≪	Point 2	≫ ↓ ≪	Point 4	≫ ↓ ≪	Point 3
Calculated S (in)	1.72		2.32		20.13		13.18
Differential S (in)		0.60		17.81		6.98	
Distance (ft)		104		510		260	
Initial Elevation (ft)	137		104		118		126
Initial Slope Length (ft)		109.11		510.19		260.12	
Initial Slope (%)		31.73		2.75		3.08	
Final Elevation (ft)	136.86		103.81		116.32		124.90
Final Slope length (ft)		109.13		510.15		260.14	
Final Slope (%)		31.78		2.45		3.30	
Estimated Strain (%)		0.014		-0.008		0.007	

Final Slope(s): Final slope values (%) between Points 2 and 4, and between Points 4 and 3 are displayed in red font. These are locations of the leachate collection header pipe where a minimum 2% slope is required. In both cases, a minimum 2% slope is maintained.

Estimated Strain: Estimated strain values (%) between Points 1 and 2, and between Points 4 and 3 are displayed in red font. These are locations where the geomembrane liner could experience an increase in length. Information from a geomembrane manufacturer (Ref. 9) indicates the 60-mil textured HDPE geomembrane experiences 12% elongation (strain) at yield. The estimated strains calculated here are less than that for material yield.

b. Cell 13 Evaluation

Variable	Point 1	≫ ↓ ≪	Point 2	≫ ↓ ≪	Point 3
Calculated S (in)	0.78		1.14		14.29
Differential S (in)		0.36		13.15	
Distance (ft)		21		440	
Initial Elevation (ft)	87		80		94
Initial Slope Length (ft)		22.14		440.22	
Initial Slope (%)		33.33		3.16	
Final Elevation (ft)	86.94		79.91		92.81
Final Slope length (ft)		22.15		440.19	
Final Slope (%)		33.48		2.93	
Est. Strain (%)		0.043		-0.008	

Final Slope: Final slope values (%) between Points 2 and 3 are displayed in red font. This is the location of the leachate collection header pipe where a minimum 2% slope is required. A minimum 2% slope is maintained.

Estimated Strain: Estimated strain values (%) between Points 1 and 2 are displayed in red font. This location is where the geomembrane liner could experience an increase in length. Information from a geomembrane manufacturer (Ref. 9) indicates the 60-mil textured HDPE geomembrane experiences 12% elongation (strain) at yield. The estimated strain calculated here is less than that for material yield.

c. Conclusions

Based on the foregoing, the following conclusions are offered:

1. The settlement experienced by the landfill will affect the slope of the floor of the landfill. The main leachate collection headers should maintain the minimum required 2% slope.
2. The geomembrane will experience some strain induced by an increase in length due to the differential settlement between points. However, the strain should be less than that required for the material to yield.

Reviewed by PGS 09/01/2021

9. References

1. Project Laboratory Test Data.

2. Project Soil Boring Logs.

3. Project Design Information.

4. Holtz, Robert D., and Kovacs, William D.; *"An Introduction to Geotechnical Engineering"*; 1981, Prentice-Hall, Inc., Fig. 8.6 and p 296.

5. Terzaghi, Karl, and Peck, Ralph B.; *"Soil Mechanics in Engineering Practice"*; 2nd Ed., 1967, John Wiley and Sons, Inc.; Table 45.1 (p 341), Table 45.2 (p 347).

6. University of Massachusetts at Lowell; *"14.485 Capstone Design, Module 4 – Geotechnical Engineering"*, Table 1 (Slide 16 of 43).

7. Das, Braja M.; *"Principles of Geotechnical Engineering"*; 2nd Ed., 1990, PWS-KENT Publishing Company.

8. Sowers, George F.; *"Introductory Soils Mechanics and Foundations: Geotechnical Engineering"*; 1979, Macmillan Publishing Co., Inc.

9. Manufacturer's information on HDPE textured geomembrane.

REFERENCE 4

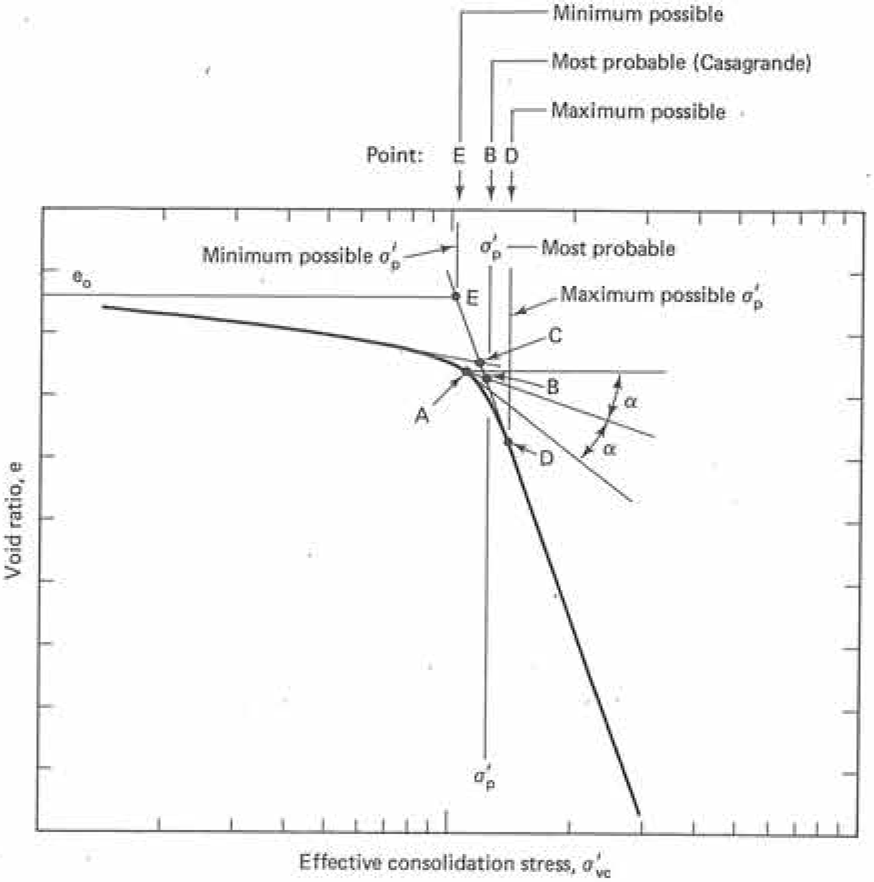


Fig. 8.6 The Casagrande (1936b) construction for determining the preconsolidation stress. Also shown are the minimum possible, the most probable, and the maximum possible preconsolidation stresses.

Casagrande procedure is as follows:

1. Choose by eye the point of minimum radius (or maximum curvature) on the consolidation curve (point *A* in Fig. 8.6).
2. Draw a horizontal line from point *A*.
3. Draw a line tangent to the curve at point *A*.
4. Bisect the angle made by steps 2 and 3.
5. Extend the straight line portion of the *virgin* compression curve up to where it meets the bisector line obtained in step 4. The point of intersection of these two lines is the preconsolidation stress (point *B* of Fig. 8.6).

REFERENCE 1

MW-28

depth = 2'

CONSOLIDATION

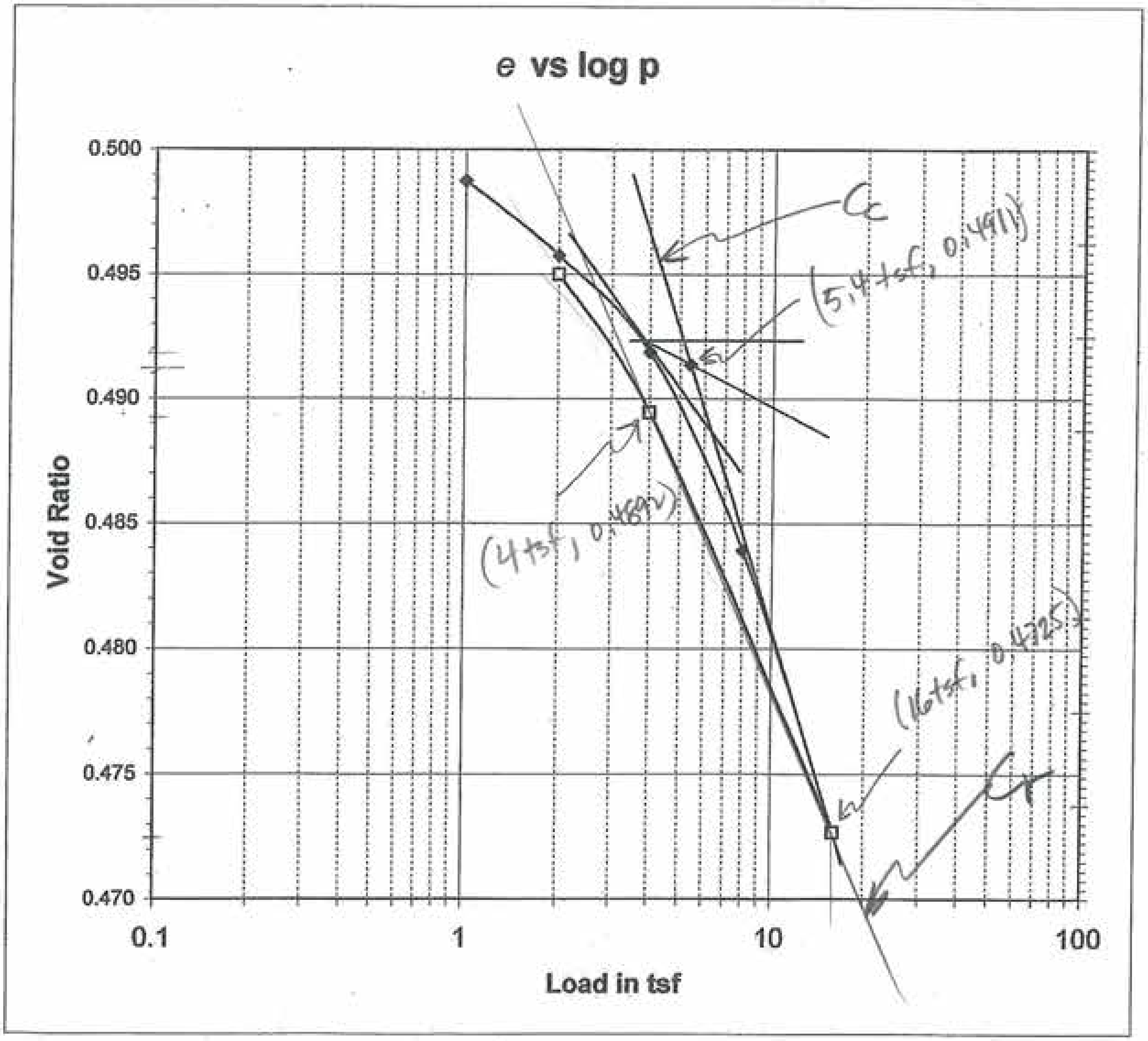
Project: Chesapeake Rubble Landfill
Job #: 02231
Lab #: 030081
Sample Location: On Site
Sample Description: Maroon & Gray Clay

Date: Apr-03

Specific Gravity: 2.8
Moisture Content: 17.3%
Sample Dia: 2.500"
Initial Sample Len: 1.000"

Unit Wt. Wet: 136.8 pcf
Unit Wt. Dry: 116.6 pcf
Initial Void Ratio: 0.499

Preconsolidation Pressure: 5.4 tsf

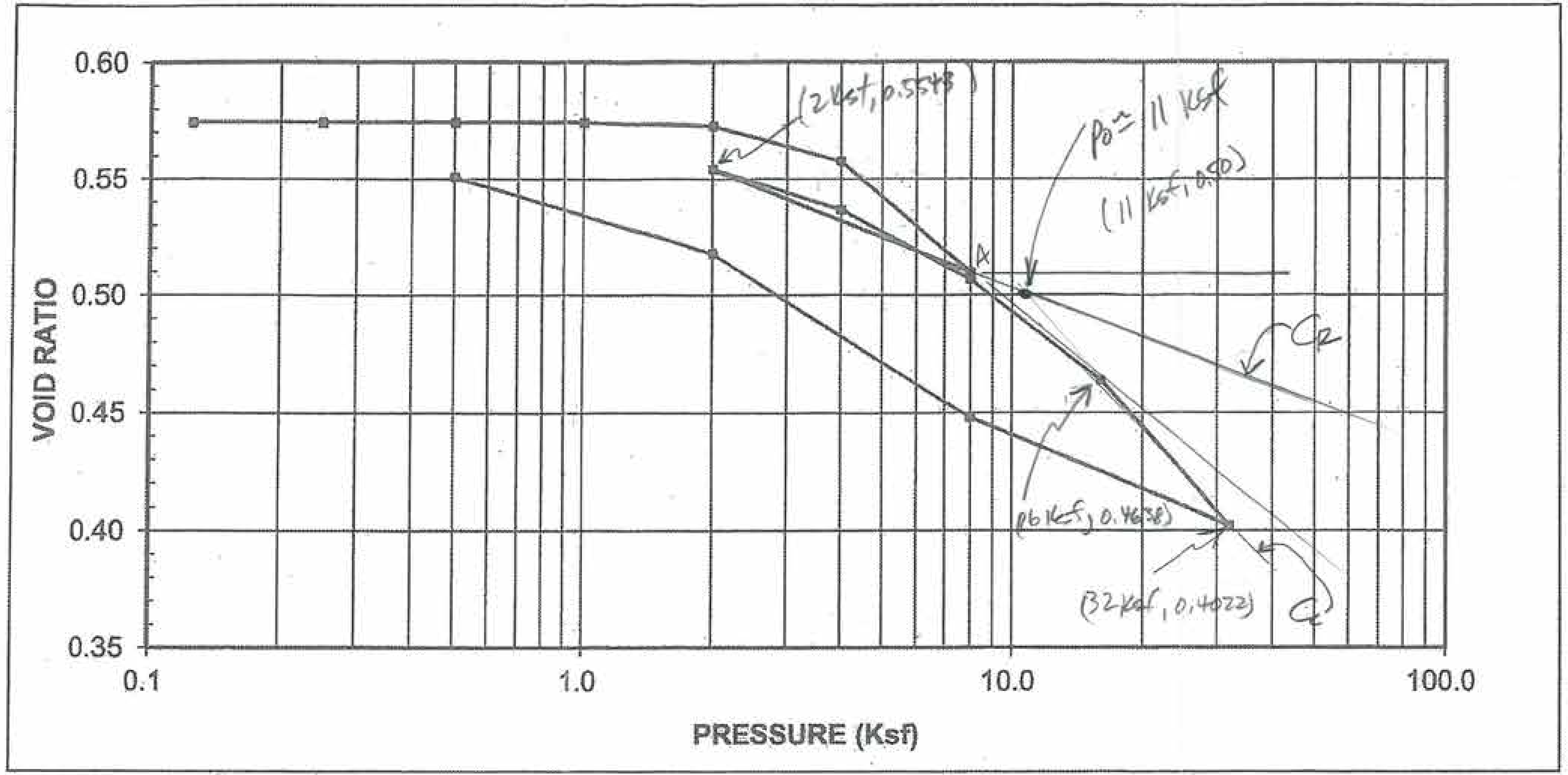


HARDIN-KIGHT ASSOCIATES, INC.
7524 WB&A Road, Suite 100
Glen Burnie, Maryland 21061

Phone: 410 553-0802
Fax: 410 553-0808
Emial: HKAI@Erols.com

REFERENCE 1

ONE - DIMENSIONAL CONSOLIDATION
ASTM D 2435 Method B



SAMPLE ID PMW - 23
SAMPLE TYPE UD
SAMPLE DEPTH 128.0 - 130.0'

LL -
PL -
PI -
Gs 2.80

	Initial	Final
Dry Unit Weight (pcf)	111.1	111.1
Wet Unit Weight (pcf)	134.5	138.6
Moisture Content	21.0%	24.8%
Void Ratio	0.574	0.574
Degree of Saturation	100%	100%

DESCRIPTION CLAY; dark reddish brown and gray; Hard (can indent with thumb nail); dry to moist.
USCS (CH)

NWM/CHESAPEAKE TERRACE SFI/MD
063-1431-003

TECH PWM
DATE 10/17/13
CHECK
REVIEW
APPROVE

MW-28

$$C_c = \frac{\Delta e}{\log\left(\frac{\sigma_2'}{\sigma_1'}\right)} = \frac{(0.4911 - 0.4725)}{\log\left(\frac{16}{5.4}\right)} = 0.039$$

$$C_R = \frac{\Delta e}{\log\left(\frac{\sigma_2'}{\sigma_1'}\right)} = \frac{(0.4892 - 0.4725)}{\log\left(\frac{16}{4}\right)} = 0.028$$

PMW-23

$$C_c = \frac{\Delta e}{\log\left(\frac{\sigma_2'}{\sigma_1'}\right)} = \frac{(0.5000 - 0.4022)}{\log\left(\frac{32}{11}\right)} = 0.211$$

$$C_R = \frac{\Delta e}{\log\left(\frac{\sigma_2'}{\sigma_1'}\right)} = \frac{(0.5543 - 0.5000)}{\log\left(\frac{11}{2}\right)} = 0.073$$

Ref: Holtz & Kovacs (1981) pg 313, eq'n 8-7.

SHEET 1 OF 1 PROJECT NO. ______ PROJECT NAME Ches. Terr LF
BY JCA DATE 11/20/19 DESCRIPTION Cc & CR
CHK. BY ______ DATE ______

REFERENCE 1

UNCONFINED COMPRESSION OF COHESIVE SOIL

Project: Chesapeake Rubble Fill
Job #: 02231
Lab #: 030081
Sample Location: On Site
Sample Description: Maroon & Gray Clay
Method: ASTM D2166

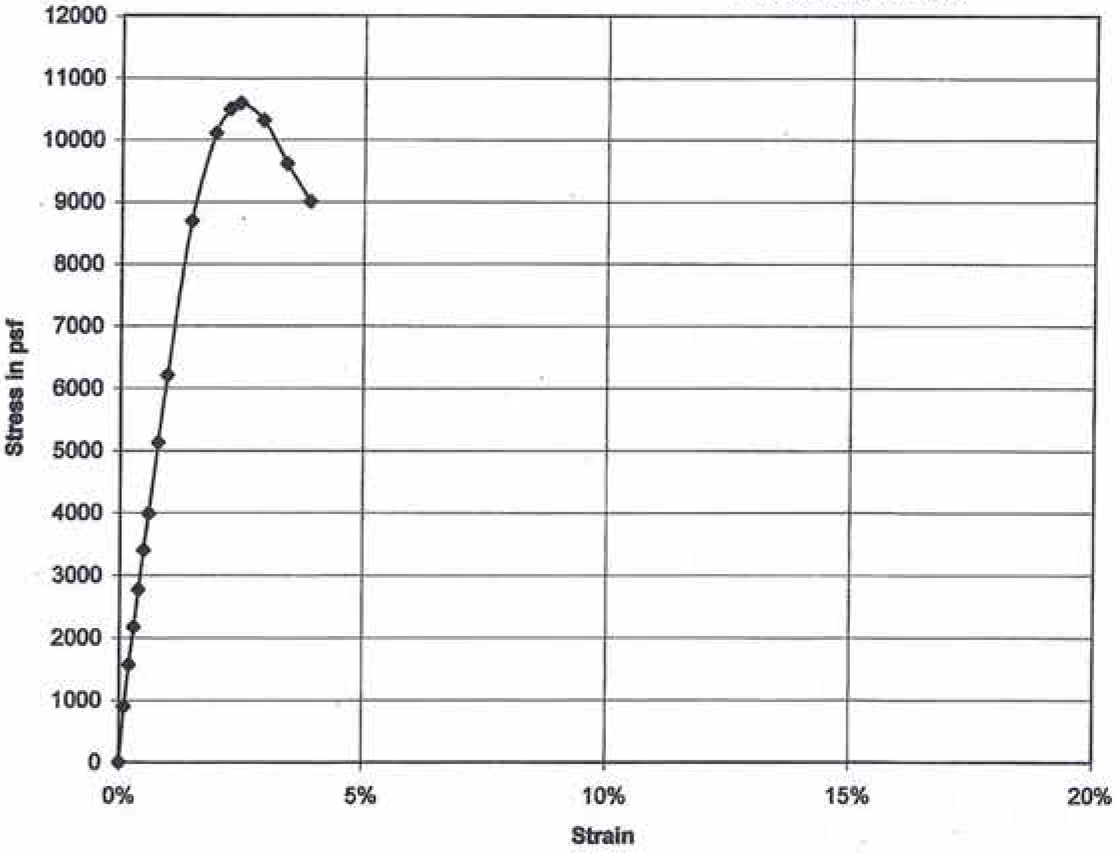
Date: 4/17/2003

Length:	5.140"	Initial Wet Wt.:	1138.47g	Initial Wet Unit Wt.:	132.4pcf
Diameter:	2.848"	Final Wet Wt.:	1136.48g	Final Wet Unit Wt.:	132.2pcf
Area:	6.371in^2	Dry Wt:	1083.46g	Dry Unit Wt.:	115.1pcf
Volume:	32.750in^3	Initial Moisture:	15.0%	L/D:	1.8

Load Rate: .045"/min

Stress-Strain Curve

Maximun Stress: 10594psf
Percent Strain: 2.4%



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REFERENCE 5

was secured concerning the geology of the site, a list of the index properties of all the spoon samples that were taken, and a record of the results of the standard penetration tests. On the basis of this report it can be decided whether or not supplementary investigations are required concerning the relative density and permeability of the sand strata and the shearing resistance and compressibility of the clay strata.

Relative Density of Sand Strata

The relative density of sand strata has a decisive influence on the angle of internal friction of the sand (Article 17), on the ultimate bearing capacity (Article 33), and on the settlement of footings resting on the sand. If a submerged sand is very loose, a sudden shock may transform it temporarily into a sand suspension with the properties of a thick viscous liquid (Article 17). In a dense state the same sand is insensitive to shock and is perfectly suitable as a base for even very heavy structures. For this reason the relative density of a sand is far more important than any of its other properties, except possibly its permeability.

Table 45.1
Relative Density of Sands according to Results of Standard Penetration Test

No. of Blows N	Relative Density
0–4	Very loose
4–10	Loose
10–30	Medium
30–50	Dense
Over 50	Very dense

While the exploratory borings are being made, some information regarding the relative density of the sand strata encountered in the drill holes can be obtained by performing the standard penetration test (page 304) whenever a spoon sample is taken. Considering the outstanding importance of the relative density, the standard penetration test should be considered an essential part of the boring operation. Table 45.1 gives an approximate relation between the number of blows N and the relative density.

The relation, Table 45.1, should be used with caution, and only if the penetration tests are carried out conscientiously. If the sand

REFERENCE 5

Table 45.2
Relation of Consistency of Clay, Number of Blows N on Sampling Spoon, and Unconfined Compressive Strength

	q_u in tons/ ft²					
Consistency	Very Soft	Soft	Medium	Stiff	Very Stiff	Hard
N	<2	2–4	4–8	8–15	15–30	>30
q_u	<0.25	0.25–0.50	0.50–1.00	1.00–2.00	2.00–4.00	>4.00

routine tests on the spoon samples, listed in Table 9.1, are also obligatory because their results are required for comparing the clay with others previously encountered on similar jobs. The values of q_u obtained by means of compression tests are likely to be somewhat too low because spoon samples are appreciably disturbed. The supplementary investigations required on important jobs depend on the character of the soil profile.

If the soil profile is simple and regular, it is commonly possible to evaluate the average shearing resistance of the clay strata on the basis of the results of laboratory tests. The samples are secured by means of tube sample borings (Article 44) which furnish continuous cores. To obtain fairly reliable average values, the spacing between the sample borings should not exceed 100 ft. If it is known in advance that the soil profile is fairly regular and that tube sample borings will be required, continuous samples are taken in all those sections of the exploratory holes that are located within clay strata. In the sections located between clay strata spoon samples are extracted, and standard penetration tests are made.

The samples are delivered to the laboratory in sealed tubes commonly 30 or 36-in. long. Preferably, all the clay samples from one hole should be tested in the sequence in which they followed each other in the drill hole in a downward direction. Each sample is ejected from its tube by means of a close-fitting plunger in such a manner that the sample continues to move with respect to the tube in the same direction as it entered; if excessive side friction causes too much disturbance during ejection, the tube is cut into 6-in. sections, the soil itself is cut by means of a wire saw, and each section is ejected.

For routine testing each sample is cut into sections with lengths equal to about three times the diameter; that is, 2-in. tube samples

REFERENCES

SOIL ENGINEERING PROPERTY CORRELATIONS FROM IN-SITU TESTING (TABLE 1)

Soil	Density/Consistency	N	q_t (MPa)	γ_t (pcf)	ϕ' (°)
SANDS	V. Loose	0-4	0-2	90-105	<30
	Loose	5-10	2-5	95-110	30-35
	Medium Dense	11-30	5-15	105-120	35-38
	Dense	31-50	15-25	115-130	38-41
	Very Dense	>50	>25	125-140	41-44
COHESIVE SOILS	Very Soft	0-2	0-0.5	90-100	NA
	Firm	2-8	0.5-1.5	90-110	
	Stiff	9-15	1.5-3	105-125	
	Very Stiff	15-30	3-6	115-135	
	Hard	>30	>6	120-140	

after Fang et al. (1991) and EM 1110-1-1905.

NOTE: 1 MPa = 10.44 tsf

REFERENCE 7

Table 2.1 Various Forms of Relationships for γ, γ_d, and γ_{sat}

Unit-weight relationship	Eq. no.
$\gamma = \frac{(1+w)G_s\gamma_w}{1+e}$	(2.15)
$\gamma = \frac{(G_s+Se)\gamma_w}{1+e}$	(2.26)
$\gamma = \frac{(1+w)G_s\gamma_w}{1+\frac{wG_s}{S}}$	(2.27)
$\gamma = G_s\gamma_w(1-n)(1+w)$	(2.28)
Dry unit weight	
$\gamma_d = \frac{\gamma}{1+w}$	(2.12)
$\gamma_d = \frac{G_s\gamma_w}{1+e}$	(2.16)
$\gamma_d = G_s\gamma_w(1-n)$	(2.22)
$\gamma_d = \frac{G_s}{1+\frac{wG_s}{S}}\gamma_w$	(2.29)
$\gamma_d = \frac{eS\gamma_w}{(1+e)w}$	(2.30)
$\gamma_d = \gamma_{sat} - n\gamma_w$	(2.31)
$\gamma_d = \gamma_{sat} - \left(\frac{e}{1+e}\right)\gamma_w$	(2.32)
Saturated unit weight	
$\gamma_{sat} = \frac{(G_s+e)\gamma_w}{1+e}$	(2.18) ✓
$\gamma_{sat} = [(1-n)G_s+n]\gamma_w$	(2.24)
$\gamma_{sat} = \left(\frac{1+w}{1+wG_s}\right)G_s\gamma_w$	(2.33)
$\gamma_{sat} = \left(\frac{e}{w}\right)\left(\frac{1+w}{1+e}\right)\gamma_w$	(2.34)
$\gamma_{sat} = \gamma_d + n\gamma_w$	(2.35)
$\gamma_{sat} = \gamma_d + \left(\frac{e}{1+e}\right)\gamma_w$	(2.36)

The proofs of some of these relationships are left to the students.

(Equation 2.18)

$$\gamma = \frac{(G_s+e)\gamma_w}{(1+e)}$$

$$\gamma(1+e) = (G_s+e)\gamma_w$$

$$\gamma + \gamma e = G_s\gamma_w + e\gamma_w$$

$$\gamma e - e\gamma_w = G_s\gamma_w - \gamma$$

$$e(\gamma-\gamma_w) = G_s\gamma_w - \gamma$$

$$e = \frac{(G_s\gamma_w - \gamma)}{(\gamma-\gamma_w)}$$

GENERAL SOIL PROFILE: CELL 10**, POINT** 1 (NOT TO SCALE)

General Existing Profile (elev)	General Final Profile (elev)
Boring Profile: B-105 TOG = 161	
Sand w/fines, some gravel Navg=8 146	
Silty Clay to Clay w/trace Sand Navg=42 116	137 (Edge of Landfill)
Silty Clay to Clay w/trace sand ∇ 97 Navg=66 61	

RECORD OF BOREHOLE

B-105

SHEET 1 of 2

PROJECT: Chesapeake Terrace SFI
PROJECT NUMBER: 063-1431-003
DRILLED DEPTH: 100.0 ft
AZIMUTH: N/A
LOCATION: Odenton, MD

DRILL METHOD: Mud Rotary- 3 in.
DRILL RIG: Simco 2800
DATE STARTED: 5/2/13
DATE COMPLETED:
WEATHER: Partly Cloudy

DATUM:
COORDS: N: 500,589.1 E: 1,386,809.5
GS ELEVATION: 115.7 ft
TOC ELEVATION: NA
TEMPERATURE: 50 F

INCLINATION: -90
DEPTH W.L.: NA

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE				SAMPLES					COMMENTS
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in	N	REC / ATT	
0	115								⑥		
5	110	3.0 - 5.0 SAND; fine to medium, well-graded, subrounded; trace plastic fines, trace fine gravel; light brown; noncohesive; moist; loose.	SW		110.7	S1	DO	2-3-3-3	6	0.6/2.0	
									⑦		Sa Navg=8
10	105	8.0 - 10.0 SAND; fine, poorly graded, subrounded; some plastic fines, trace coarse subangular gravel, lenses of soft red and white clay; light brown; noncohesive; moist; loose.	SP		105.7	S2	DO	2-3-4-3	7	1.0/2.0	
									⑫		
15	100	13.0 - 15.0 SAND; fine to medium, well-graded, subrounded; some nonplastic fines, trace subangular coarse gravel, seams of light grey clay, lenses of clayey sand; light grey to light brown; trace organics; noncohesive; moist; compact.	SW		100.7	S3	DO	3-4-8-14	12	1.5/2.0	
									㊶		
20	95	18.0 - 20.0 SILTY CLAY; medium plasticity; seams of fine dark grey sand; dark red, slightly shiny; cohesive; w<PL; stiff.	CL		95.7	S4	DO	11-19-22-23	41	1.6/2.0	
									(84)		
25	90	23.0 - 25.0 SILTY CLAY; medium plasticity; mottled dark grey and brownish red, slightly shiny; cohesive; w<PL; very stiff.	CL		90.7	S5	DO	17-39-45-45	84	1.8/2.0	Silt to Cl
									㉜		
30	85	28.0 - 30.0 CLAY; high plasticity; grey mottled dark red and maroon, shiny; thinly laminated; trace black material: possibly organics; cohesive; w~PL; stiff.	CH		85.7	S6	DO	12-16-16-32	32	1.9/2.0	Navg=42
									㉘		
35	80	33.0 - 35.0 CLAY; high plasticity; grey mottled dark red and maroon, shiny; thinly laminated; trace black material: possibly organics; cohesive; w~PL; stiff.	CH		80.7	S7	DO	11-13-15-25	28	2.0/2.0	
									㉟		
40	75	38.0 - 40.0 SILTY CLAY; medium plasticity; some fine sand; light grey mottled dark red, slightly shiny; thinly laminated; cohesive;, w~PL; stiff.	CL		75.7	S8	DO	12-15-20-22	35	1.0/2.0	
									㉝		
		43.0 - 44.0 CLAYEY SILT, low to medium plasticity; some fine sand, trace of fine gravel; light grey, dull; cohesive; stiff.	ML		71.7	S9	DO	12-15-18-23	33	2.0/2.0	
45	70	44.0 - 45.0 CLAY; medium to high plasticity; brown and purple mottled yellowish brown, shiny; thinly laminated; cohesive; stiff.	CH		44.0 70.7						
									(64)		
50	65	48.0 - 50.0 SILTY CLAY; medium to high plasticity; trace fine sand, pockets of fine yellow-brown sand; light grey, slightly shiny; cohesive; w~PL; stiff.	CL		65.7	S10	DO	17-26-38-40	64	0.7/2.0	SiCl to Cl Navg=64

Log continued on next page

LOG SCALE: 1 in = 6.5 ft
DRILLING COMPANY: Earth Matters Inc.
DRILLER: D. Taylor

GA INSPECTOR: KMC
CHECKED BY: VEF
DATE: 8/8/13

Golder Associates

RECORD OF BOREHOLE B-105

SHEET 2 of 2

PROJECT: Chesapeake Terrace SFI
PROJECT NUMBER: 063-1431-003
DRILLED DEPTH: 100.0 ft
AZIMUTH: N/A
LOCATION: Odenton, MD

DRILL METHOD: Mud Rotary- 3 in.
DRILL RIG: Simco 2800
DATE STARTED: 5/2/13
DATE COMPLETED:
WEATHER: Partly Cloudy

DATUM:
COORDS: N: 500,589.1 E: 1,386,809.5
GS ELEVATION: 115.7 ft
TOC ELEVATION: NA
TEMPERATURE: 50 F

INCLINATION: -90
DEPTH W.L.: NA

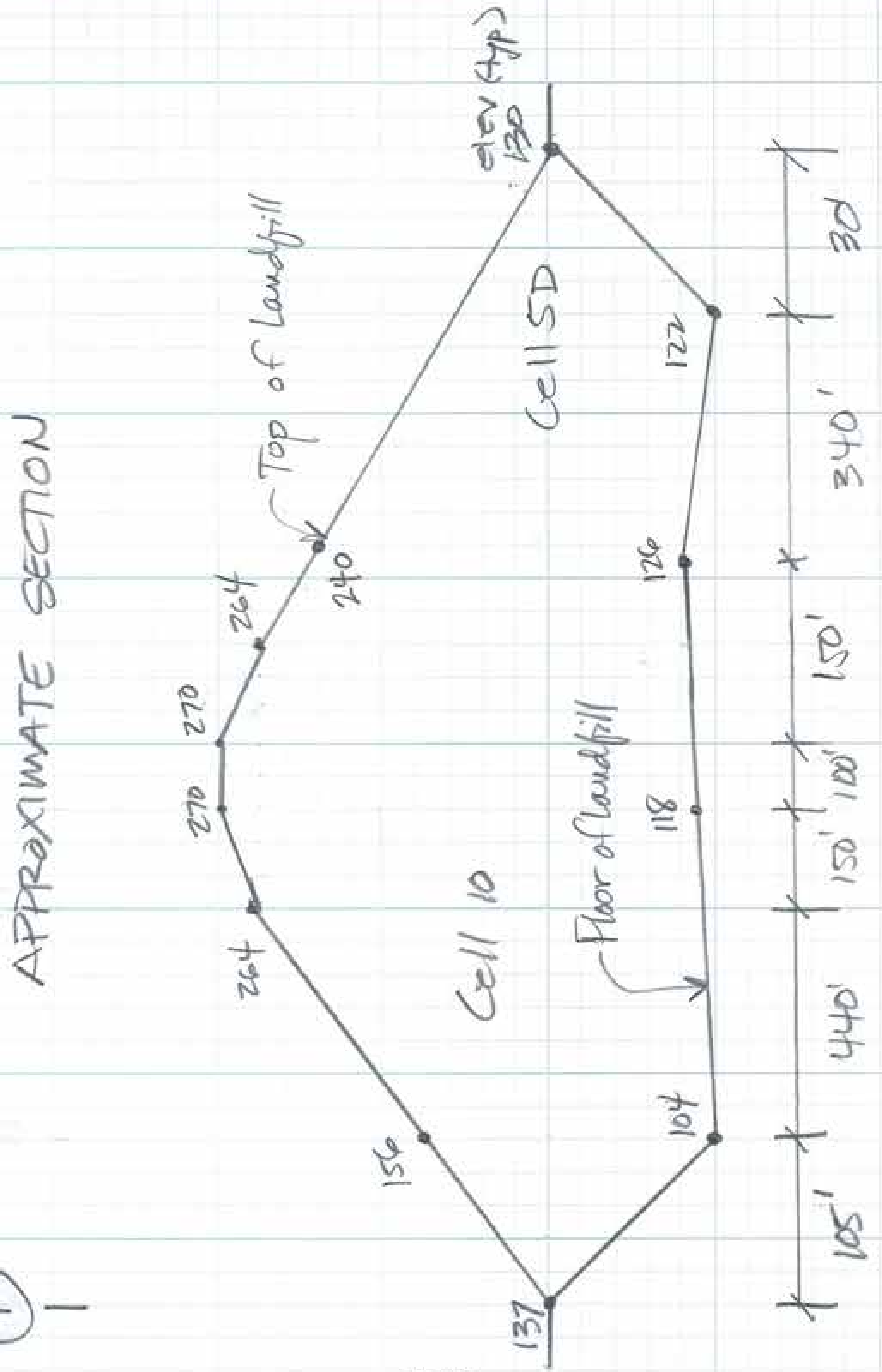
		SOIL PROFILE				SAMPLES					
DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in	N	REC / ATT	COMMENTS
55	60	53.0 - 55.0 SILTY CLAY; medium plasticity; seams of fine sand; reddish brown mottled light grey, slightly shiny; cohesive; w~PL; stiff.	CL	▨	60.7	S11	DO	21 -37 -47 -50/5"	84 84	1.2 / 2.0	
60	55	58.0 - 60.0 SILTY CLAY; medium to high plasticity; trace fine sand; light grey mottled reddish brown, lightly shiny; cohesive; w~PL; firm.	CL	▨	55.7	S12	DO	16 -18 -22 -30	40 40	1.7 / 2.0	
65	50	63.0 - 65.0 SILTY CLAY; low to medium plasticity; light grey mottled reddish brown, slightly shiny; cohesive; w~PL; stiff.	CL	▨	50.7	S13	DO	21 -33 -36 -42	99 99	0.7 / 2.0	
70	45	68.0 - 70.0 CLAY; high plasticity; purplish grey mottled dark red, shiny; cohesive; w<PL; very stiff.	CH	▨	45.7	S14	DO	18 -24 -27 -30	51 51	2.0 / 2.0	
75	40	73.0 - 75.0 CLAY; high plasticity; some nonplastic fines, pockets of fine sand; grey and purple mottled dark red, shiny; thinly laminated; cohesive; w~PL; stiff to very stiff.	CH	▨	40.7	S15	DO	17 -21 -31 -34	52 52	2.0 / 2.0	
80	35	78.0 - 80.0 SILTY CLAY; low to medium plasticity; trace fine sand, pockets of fine sand; light grey mottled dark red, slightly shiny; thinly laminated; cohesive; w~PL; stiff to very stiff.	CL	▨	35.7	S16	DO	24 -26 -40 -50	76 76	1.9 / 2.0	
85	30	83.0 - 83.8 SILTY CLAY; medium to high plasticity; trace of fine sand; mottled light grey and dark red; cohesive; w~PL; stiff to very stiff.	CL	▨	31.9	S17	DO	22 -22 -23 -35	45 45	1.8 / 2.0	
		83.8 - 84.8 CLAY; medium to high plasticity; some nonplastic fines, trace of fine sand; dark red mottled light grey; cohesive; w~PL; firm to stiff.	CH	▨	83.8 30.9						
90	25	88.0 - 90.0 CLAYEY SILT and SAND; low to medium plasticity; ~35% fine sand, pockets of fine sand, lens of soft red clay; light grey mottled dark red and brown, slightly shiny; cohesive; w<PL; stiff.	MH	▥	25.7	S18	DO	15 -22 -38 -39	60 60	2.0 / 2.0	
95	20	93.0 - 95.0 CLAYEY SILT; low to medium plasticity; some fine sand, pockets of fine sand, seams of clay and fine sand; light grey mottled dark red and brown, slightly shiny; cohesive; w<PL; stiff.	MH	▥	20.7	S19	DO	30 -40 -50/5"	100 N/A	1.5 / 2.0	Drilled w/o sampling. (94.4'-95')
100	15	98.0 - 100.0 SILTY CLAY; medium to high plasticity; lenses of fine clayey sand; purplish brown, slightly shiny; cohesive; w<PL; stiff.	CL	▨	15.7	S20	DO	19 -22 -37 -42	59 59	1.6 / 2.0	
		Boring completed at 100.0 ft									

LOG SCALE: 1 in = 6.5 ft
DRILLING COMPANY: Earth Matters Inc.
DRILLER: D. Taylor

GA INSPECTOR: KMC
CHECKED BY: VEF
DATE: 8/8/13

Golder Associates

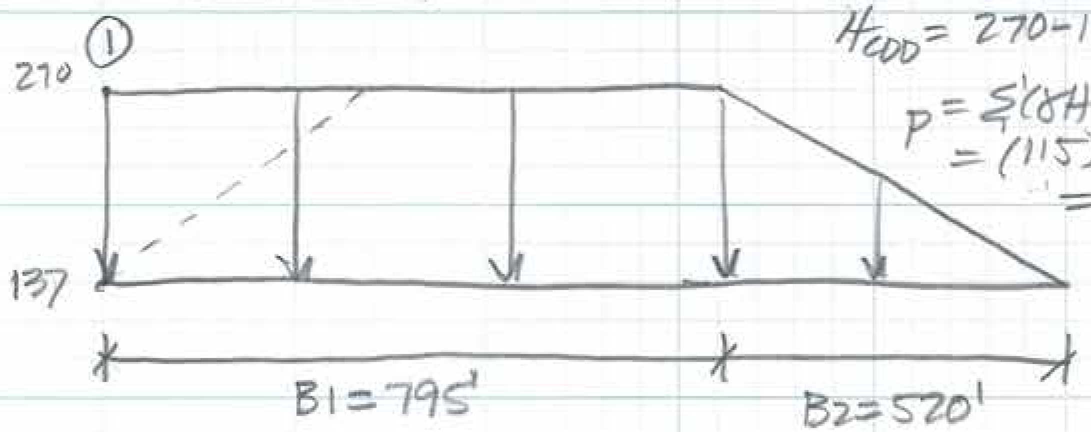
AA GEOTECH LOG NO PID CHESAPEAKE SFI.GPJ GOLDER NJ-PA 05-24-06.GDT 9/27/13



APPROXIMATE SECTION

SHEET 1 OF 1 PROJECT NO. 2018-3084 PROJECT NAME Chester
BY JCA DATE 7/5/20 DESCRIPTION Cell 10, Point 1 Settlement
CHK. BY DATE

Waste Load U1



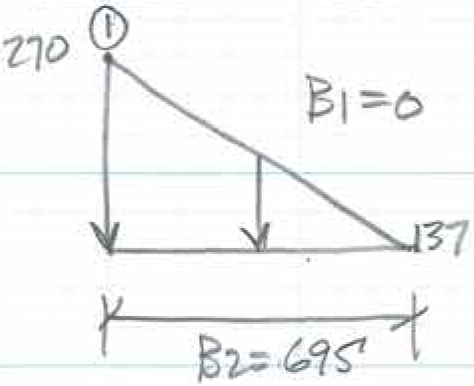
$H_{CDD} = 270-137-3' = 130$

$p = \sum_{1}^{2}(\gamma H)$

$= (115)(3') + (130')(48.7)$

$= 6676$ psf

Waste Load U2

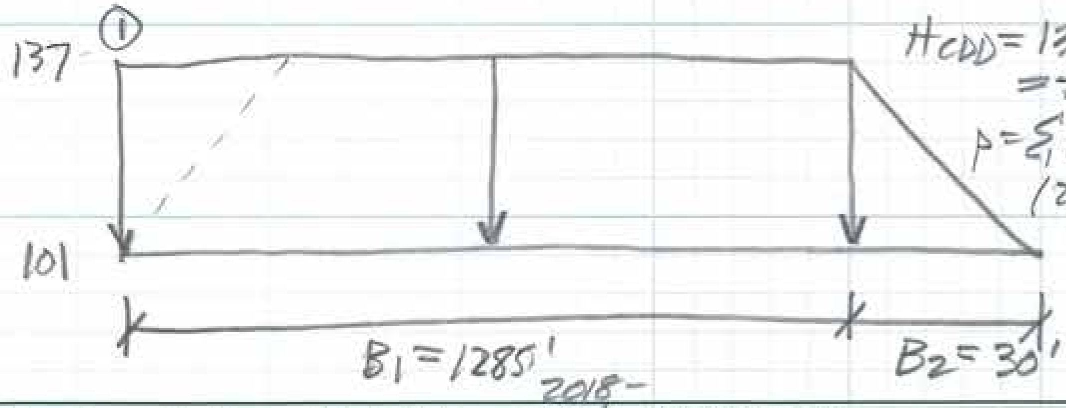


$H_{CDD} = 270-137-3 = 130$

$p = \sum_{1}^{2}(\gamma H) = (3)(115) + (130)(48.7)$

$= 6676$ psf

Waste Load L1



$H_{CDD} = 137-104-6$

$= 27'$

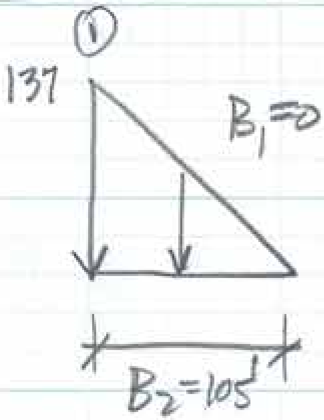
$p = \sum_{1}^{2}(\gamma H) =$

$(27')(48.7) + (6)(115)$

$= 2005$ psf

SHEET 1 OF 2 PROJECT NO. 2018-3081 PROJECT NAME
BY JCA DATE 7/5/20 DESCRIPTION Cell 10, Point 1 Loads
CHK. BY DATE

Waste Load L_2



$H_{CDD} = 137 - 104 - 6 = 27'$

$p = \Sigma(\gamma H) = (27)(48.7) + 6(115) = 2005$ psf

Net load $= U_1 - U_2 + L_1 - L_2$

SHEET 2 OF 2 PROJECT NO. 2018-3084 PROJECT NAME
BY JCA DATE 7/5/20 DESCRIPTION Cell 10, Point Loads
CHK. BY DATE

Settlement Analysis

Cell 10 **Point** 1
Boring Profile: B-105

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_e)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Initial Effective Vertical Stress at Bottom of Soil Layer (psf)	Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)
1	Sand w/some fines, gravel	161	146	15	8	101.5	0	101.5	761	0.761	1,523	761
2	Silty Clay to Clay w/trace sand	146	116	30	42	145.0	0	145.0	3,698	3.698	5,873	3,698
3	Clay w/some silt, w/trace sand	116	97	19	42	145.0	0	145.0	7,250	7.250	8,628	7,250
4	Clay w/some silt, w/trace sand	97	-822	919	66	145.0	62.4	82.6	46,582	46.582	84,537	46,582
			Total:	983								

Intermediate Profile >>>> With excavation, soil is now over-consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_e)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Intermediate Effective Vertical Stress at Bottom of Soil Layer (psf)
2	Silty Clay to Clay w/trace sand	138	116	22	42	145.0	0	145.0	1,595	1.595	3,190
3	Clay w/some silt, w/trace sand	116	97	19	42	145.0	0	145.0	4,568	4.568	5,945
4	Clay w/some silt, w/trace sand	97	-822	919	66	145.0	62.4	82.6	43,900	43.900	81,854

Waste Load U1 B1 = 795 B2 = 520 Po = 6,676 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
2	Silty Clay to Clay w/trace sand	138	116	22	11	22	0.005	1.557	0.500	3,340
3	Clay w/some silt, w/trace sand	116	97	19	31.5	41	0.016	1.531	0.500	3,340
4	Clay w/some silt, w/trace sand	97	-822	919	500.5	960	0.198	1.009	0.481	3,211

Cell 10, Point 1, pg 1/3

Waste Load U2

B1 = 0.01 *B2 =* 695 *Po =* 6,676 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	*α 1 (radians)*	*α 2 (radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress (Δσv') at Center of Soil Layer (psf)*
2	Silty Clay to Clay w/trace sand	138	116	22	11	22	1.554	0.001	0.495	3,306
3	Clay w/some silt, w/trace sand	116	97	19	31.5	41	1.525	0.000	0.486	3,243
4	Clay w/some silt, w/trace sand	97	-822	919	500.5	960	0.947	0.000	0.301	2,013

Waste Load L1

B1 = 1285 *B2 =* 30 *Po =* 2,005 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	*α 1 (radians)*	*α 2 (radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
2	Silty Clay to Clay w/trace sand	138	116	22	11	22	0.000	1.562	0.500	1003
3	Clay w/some silt, w/trace sand	116	97	19	31.5	41	0.001	1.546	0.500	1003
4	Clay w/some silt, w/trace sand	97	-822	919	500.5	960	0.008	1.199	0.490	982

Waste Load L2

B1 = 0.01 *B2 =* 105 *Po =* 1,761 *2005*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	*α 1 (radians)*	*α 2 (radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
2	Silty Clay to Clay w/trace sand	138	116	22	11	22	1.466	0.001	0.467	822
3	Clay w/some silt, w/trace sand	116	97	19	31.5	41	1.279	0.000	0.407	718
4	Clay w/some silt, w/trace sand	97	-822	919	500.5	960	0.207	0.000	0.066	116

Load Totals

Soil Layer	*Soil Description*	*Waste Load U1 (psf)*	*Waste Load U2 (psf)*	*Waste Load L1 (psf)*	*Waste Load L2 (psf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
2	Silty Clay to Clay w/trace sand	3,340	(3,306)	1003	(822)	214
3	Clay w/some silt, w/trace sand	3,340	(3,243)	1003	(718)	382
4	Clay w/some silt, w/trace sand	3,211	(2,013)	982	(116)	2,064

Cell 10, Point 1, pg 2/3

Final Profile

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Final Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)
2	Silty Clay to Clay w/trace sand	138	116	22	42	145.0	0	145.0	1,595	214	0.214	1,809
3	Clay w/some silt, w/trace sand	116	97	19	42	145.0	0	145.0	4,568	382	0.382	4,949
4	Clay w/some silt, w/trace sand	97	-822	919	66	145.0	62.4	82.6	43,900	2,064	2.064	45,964

Elastic Settlement

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_a)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
2	Silty Clay to Clay w/trace sand	22	42	22.9518	10,041	0.214	0.000	0.01
3	Clay w/some silt, w/trace sand	19	42	22.9518	10,041	0.382	0.001	0.01
4	Clay w/some silt, w/trace sand	919	66	52.6254	23,024	2.064	0.082	0.99

Recompression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Unit Weight (pcf)	Initial Void ratio e_o	Recompression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
2	Silty Clay to Clay w/trace sand	22	2.80	145.0	0.360	0.004	0.003	3,698	1,595	1,809	0.00	0.04
3	Clay w/some silt, w/trace sand	19	2.80	145.0	0.360	0.004	0.003	7,250	4,568	4,949	0.00	0.02
4	Clay w/some silt, w/trace sand	919	2.80	145.0	0.360	0.004	0.003	46,582	43,900	45,964	0.05	0.65

Compression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Effective Unit Weight (pcf)	Initial Void ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
2	Silty Clay to Clay w/trace sand	22	2.80	145.0	0.360	0.009	0.006	3,698	1,595	1,809	0.00	0.00
3	Clay w/some silt, w/trace sand	19	2.80	145.0	0.360	0.009	0.006	7,250	4,568	4,949	0.00	0.00
4	Clay w/some silt, w/trace sand	919	2.80	145.0	0.360	0.009	0.006	46,582	43,900	45,964	0.00	0.00

Summary

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Total Calculated Settlement (in)
2	Silty Clay to Clay w/trace sand	146	116	22	0.01	0.04	0.00	**0.05**
3	Clay w/some silt, w/trace sand	116	97	19	0.01	0.02	0.00	**0.03**
4	Clay w/some silt, w/trace sand	97	-822	919	0.99	0.65	0.00	**1.64**
							Total	**1.72**

Cell 10, Point 1, pg 3/3

GENERAL SOIL PROFILE: CELL 10 **, POINT** 2 (NOT TO SCALE)

General Existing Profile (elev)

Boring Profile: B-105

TOG = 153

Sand w/ fines, some gravel

Navg = 8

138

Silty Clay to clay w/ trace sand

Navg = 42

108

Silty clay to clay w/ trace sand

▽ 97

Navg = 66

53

General Final Profile (elev)

156 (Top of Landfill)

3' Cap & Cover

46' CDD Waste

6' Liner & Leachate Collection System

101 (Floor of Landfill)

RECORD OF BOREHOLE B-105

SHEET 1 of 2

PROJECT: Chesapeake Terrace SFI
PROJECT NUMBER: 063-1431-003
DRILLED DEPTH: 100.0 ft
AZIMUTH: N/A
LOCATION: Odenton, MD

DRILL METHOD: Mud Rotary- 3 in.
DRILL RIG: Simco 2800
DATE STARTED: 5/2/13
DATE COMPLETED:
WEATHER: Partly Cloudy

DATUM:
COORDS: N: 500,589.1 E: 1,386,809.5
GS ELEVATION: 115.7 ft
TOC ELEVATION: NA
TEMPERATURE: 50 F

INCLINATION: -90
DEPTH W.L.: NA

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE				SAMPLES					COMMENTS
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in	N	REC / ATT	
0	115										
5	110	3.0 - 5.0 SAND; fine to medium, well-graded, subrounded; trace plastic fines, trace fine gravel; light brown; noncohesive; moist; loose.	SW	⁙	110.7	S1	DO	2-3-3-3	⑥ 6	0.6/2.0	Sa
10	105	8.0 - 10.0 SAND; fine, poorly graded, subrounded; some plastic fines, trace coarse subangular gravel, lenses of soft red and white clay; light brown; noncohesive; moist; loose.	SP	△	105.7	S2	DO	2-3-4-3	⑨ 7	1.0/2.0	Nag=8
15	100	13.0 - 15.0 SAND; fine to medium, well-graded, subrounded; some nonplastic fines, trace subangular coarse gravel, seams of light grey clay, lenses of clayey sand; light grey to light brown; trace organics; noncohesive; moist; compact.	SW	⁙	100.7	S3	DO	3-4-8-14	⑫ 12	1.5/2.0	———
20	95	18.0 - 20.0 SILTY CLAY; medium plasticity; seams of fine dark grey sand; dark red, slightly shiny; cohesive; w<PL; stiff.	CL	▨	95.7	S4	DO	11-19-22-23	㊶ 41	1.6/2.0	
25	90	23.0 - 25.0 SILTY CLAY; medium plasticity; mottled dark grey and brownish red, slightly shiny; cohesive; w<PL; very stiff.	CL	▨	90.7	S5	DO	17-39-45-45	(84) 84	1.8/2.0	Si Cl to Cl
30	85	28.0 - 30.0 CLAY; high plasticity; grey mottled dark red and maroon, shiny; thinly laminated; trace black material: possibly organics; cohesive; w~PL; stiff.	CH	▨	85.7	S6	DO	12-16-16-32	㉜ 32	1.9/2.0	Nag=42
35	80	33.0 - 35.0 CLAY; high plasticity; grey mottled dark red and maroon, shiny; thinly laminated; trace black material: possibly organics; cohesive; w~PL; stiff.	CH	▨	80.7	S7	DO	11-13-15-25	㉘ 28	2.0/2.0	
40	75	38.0 - 40.0 SILTY CLAY; medium plasticity; some fine sand; light grey mottled dark red, slightly shiny; thinly laminated; cohesive;, w~PL; stiff.	CL	▨	75.7	S8	DO	12-15-20-22	㉟ 35	1.0/2.0	
45	70	43.0 - 44.0 CLAYEY SILT, low to medium plasticity; some fine sand, trace of fine gravel; light grey, dull; cohesive; stiff.	ML		71.7	S9	DO	12-15-18-23	㉝ 33	2.0/2.0	———
		44.0 - 45.0 CLAY; medium to high plasticity; brown and purple mottled yellowish brown, shiny; thinly laminated; cohesive; stiff.	CH	▨	44.0 70.7						
50	65	48.0 - 50.0 SILTY CLAY; medium to high plasticity; trace fine sand, pockets of fine yellow-brown sand; light grey, slightly shiny; cohesive; w~PL; stiff.	CL	▨	65.7	S10	DO	17-26-38-40	(64) 64	0.7/2.0	SiCl to Cl Nag=64

Log continued on next page

LOG SCALE: 1 in = 6.5 ft
DRILLING COMPANY: Earth Matters Inc.
DRILLER: D. Taylor

GA INSPECTOR: KMC
CHECKED BY: VEF
DATE: 8/8/13

RECORD OF BOREHOLE

B-105

SHEET 2 of 2

PROJECT: Chesapeake Terrace SFI
PROJECT NUMBER: 063-1431-003
DRILLED DEPTH: 100.0 ft
AZIMUTH: N/A
LOCATION: Odenton, MD

DRILL METHOD: Mud Rotary- 3 in.
DRILL RIG: Simco 2800
DATE STARTED: 5/2/13
DATE COMPLETED:
WEATHER: Partly Cloudy

DATUM:
COORDS: N: 500,589.1 E: 1,386,809.5
GS ELEVATION: 115.7 ft
TOC ELEVATION: NA
TEMPERATURE: 50 F

INCLINATION: -90
DEPTH W.L.: NA

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE				SAMPLES					COMMENTS
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in	N	REC / ATT	
55	60	53.0 - 55.0 SILTY CLAY; medium plasticity; seams of fine sand; reddish brown mottled light grey, slightly shiny; cohesive; w~PL; stiff.	CL	▨	60.7	S11	DO	21 -37 -47 -50/5"	84 84	1.2/2.0	
60	55	58.0 - 60.0 SILTY CLAY; medium to high plasticity; trace fine sand; light grey mottled reddish brown, lightly shiny; cohesive; w~PL; firm.	CL	▨	55.7	S12	DO	16 -18 -22 -30	40 40	1.7/2.0	
65	50	63.0 - 65.0 SILTY CLAY; low to medium plasticity; light grey mottled reddish brown, slightly shiny; cohesive; w~PL; stiff.	CL	▨	50.7	S13	DO	21 -33 -36 -42	99 99	0.7/2.0	
70	45	68.0 - 70.0 CLAY; high plasticity; purplish grey mottled dark red, shiny; cohesive; w<PL; very stiff.	CH	▨	45.7	S14	DO	18 -24 -27 -30	51 51	2.0/2.0	
75	40	73.0 - 75.0 CLAY; high plasticity; some nonplastic fines, pockets of fine sand; grey and purple mottled dark red, shiny; thinly laminated; cohesive; w~PL; stiff to very stiff.	CH	▨	40.7	S15	DO	17 -21 -31 -34	52 52	2.0/2.0	
80	35	78.0 - 80.0 SILTY CLAY; low to medium plasticity; trace fine sand, pockets of fine sand; light grey mottled dark red, slightly shiny; thinly laminated; cohesive; w~PL; stiff to very stiff.	CL	▨	35.7	S16	DO	24 -26 -40 -50	76 76	1.9/2.0	
85	30	83.0 - 83.8 SILTY CLAY; medium to high plasticity; trace of fine sand; mottled light grey and dark red; cohesive; w~PL; stiff to very stiff.	CL	▨	31.9	S17	DO	22 -22 -23 -35	45 45	1.8/2.0	
		83.8 - 84.8 CLAY; medium to high plasticity; some nonplastic fines, trace of fine sand; dark red mottled light grey; cohesive; w~PL; firm to stiff.	CH	▨	83.8 30.9						
90	25	88.0 - 90.0 CLAYEY SILT and SAND; low to medium plasticity; ~35% fine sand, pockets of fine sand, lens of soft red clay; light grey mottled dark red and brown, slightly shiny; cohesive; w<PL; stiff.	MH	▥	25.7	S18	DO	15 -22 -38 -39	60 60	2.0/2.0	
95	20	93.0 - 95.0 CLAYEY SILT; low to medium plasticity; some fine sand, pockets of fine sand, seams of clay and fine sand; light grey mottled dark red and brown, slightly shiny; cohesive; w<PL; stiff.	MH	▥	20.7	S19	DO	30 -40 -50/5"	100 N/A	1.5/2.0	Drilled w/o sampling. (94.4'-95')
100	15	98.0 - 100.0 SILTY CLAY; medium to high plasticity; lenses of fine clayey sand; purplish brown, slightly shiny; cohesive; w<PL; stiff.	CL	▨	15.7	S20	DO	19 -22 -37 -42	59 59	1.6/2.0	
		Boring completed at 100.0 ft									

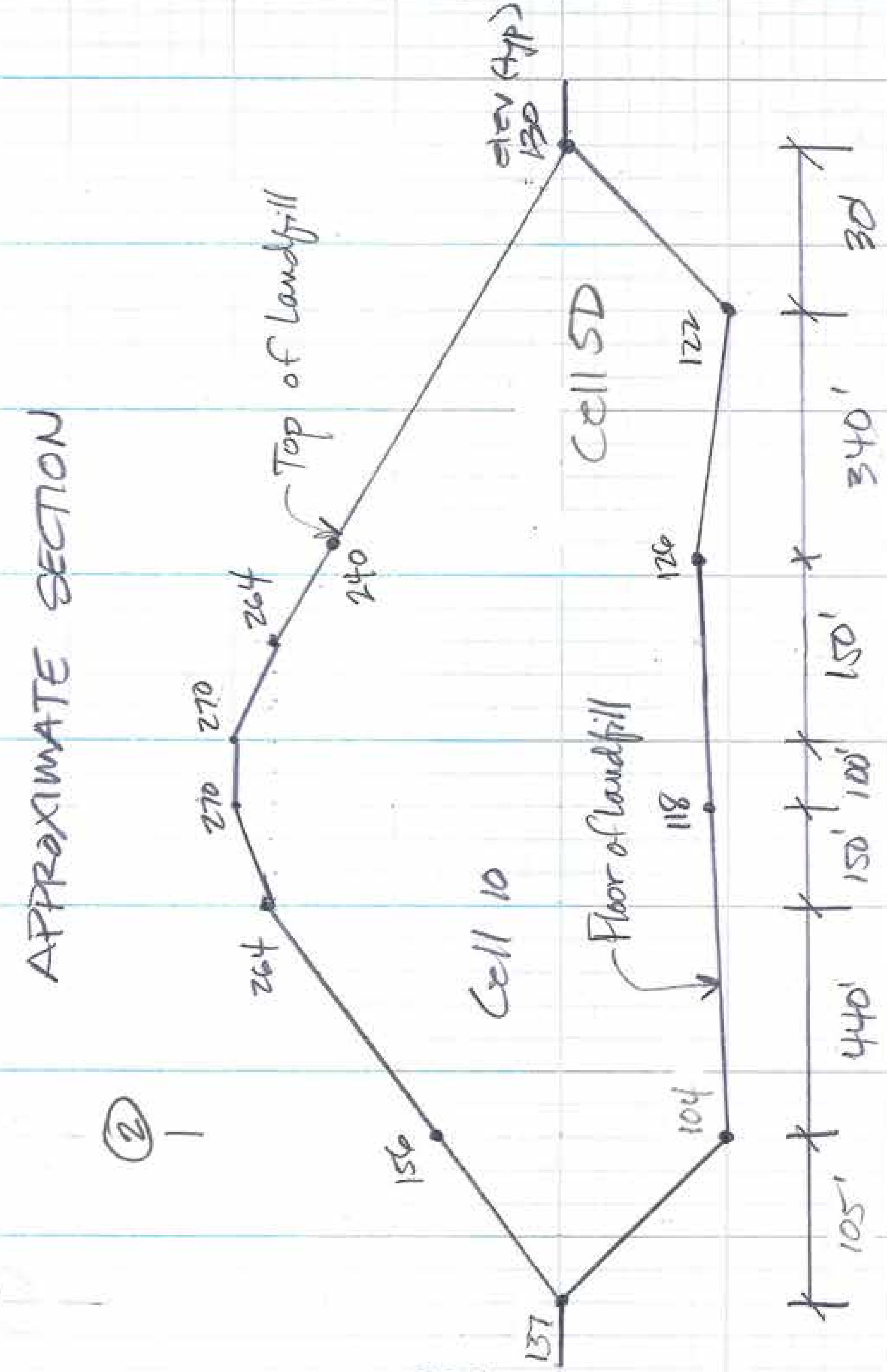
LOG SCALE: 1 in = 6.5 ft
DRILLING COMPANY: Earth Matters Inc.
DRILLER: D. Taylor

GA INSPECTOR: KMC
CHECKED BY: VEF
DATE: 8/8/13

Golder Associates

ADVANCED GeoServices

Engineering for the Environment. Planning for People.™

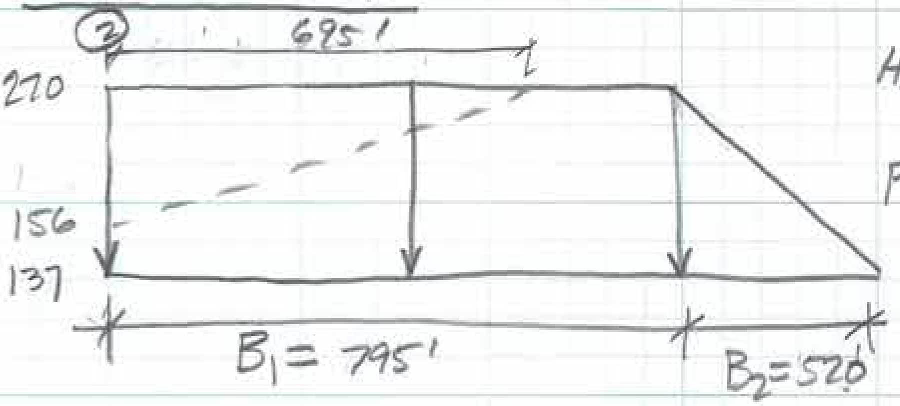


SHEET 1 OF 1 PROJECT NO. 2018-3084 PROJECT NAME Chester

BY JCA DATE 7/5/20 DESCRIPTION Cell 10, Point 2 Settlement

CHK. BY DATE

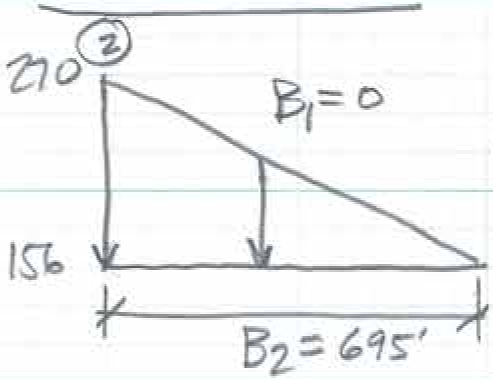
Waste Load U_1



$H_{CDD} = 270 - 137 - 3$
$= 130'$

$p = \Sigma_1^i (\gamma H)$
$= (3)(115) + (130)(48.7)$
$= 6676$ psf

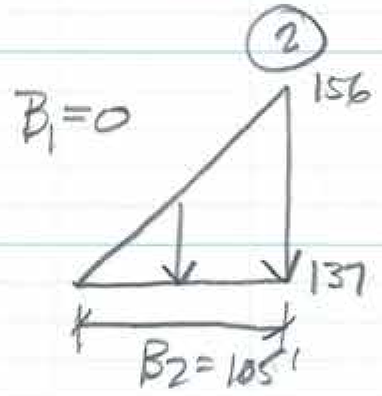
Waste Load U_2



$H_{CDD} = 270 - 156 - 3 = 111'$

$p = \Sigma_1^i (\gamma H) = (3)(115) + (111)(48.7) = 5751$

Waste Load U_3

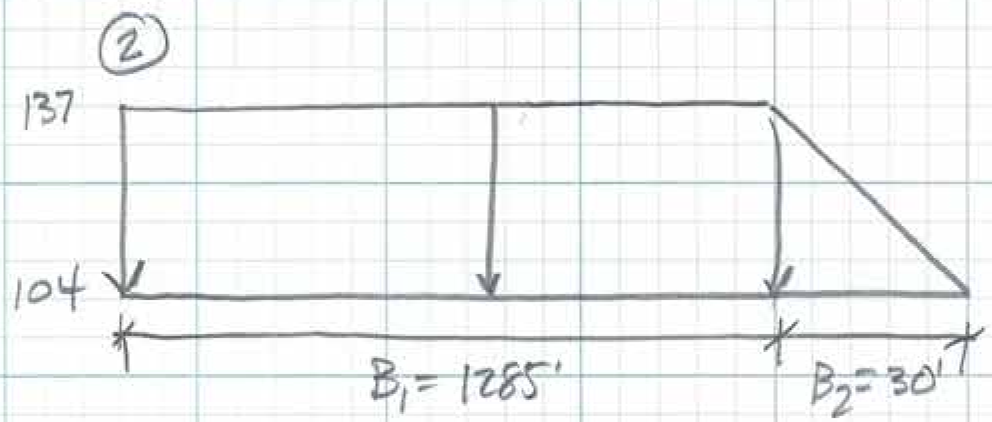


$H_{CDD} = 156 - 137 - 3 = 16'$

$p = \Sigma(\gamma H) = (3)(115) + (16)(48.7)$
$= 1124$ psf

SHEET 1 OF 2 PROJECT NO. 2018-3054 PROJECT NAME
BY JCA DATE 7/6/20 DESCRIPTION Cell 10, Point 2 Settlement
CHK. BY DATE

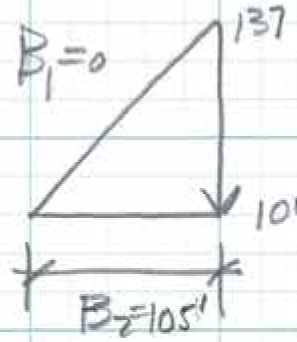
Waste Load L_1



$H_{CDD} = 137 - 104 - 6 = 27'$

$p = \Sigma_i'(\gamma H) = (27)(48.7) + (6)(115) = 2005$ psf

Waste Load L_2



$H_{CDD} = 132 - 104 - 6 = 27'$

$p = \Sigma_i'(\gamma H)$

$= (27)(48.7) + (6)(115)$

$= 2005$ psf

Net Load $= U_1 - U_2 + U_3 + L_1 - L_2$

SHEET 2 OF 2 PROJECT NO. 2018-3084 PROJECT NAME
BY JCA DATE 7/6/20 DESCRIPTION Cell 10, Point 2 Settlement
CHK. BY DATE

Cell 10 ***Point*** 2

Boring Profile: B-105

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness (ft)*	*Average SPR (N_o)*	*Estimated Soil Unit Weight (pcf)*	*Unit Weight Water (pcf)*	*Effective Soil Unit Weight (kcf)*	*Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)*	*Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)*	*Initial Effective Vertical Stress at Bottom of Soil Layer (psf)*	*Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)*
1	Sand w/some fines, gravel	153	138	15	8	101.5	0	101.5	761	0.761	1,523	761
2	Silty Clay to Clay w/trace sand	138	108	30	42	145.0	0	145.0	3,698	3.698	5,873	3,698
3	Clay w/some silt, w/trace sand	108	97	11	42	145.0	0	145.0	6,670	6.670	7,468	6,670
4	Clay w/some silt, w/trace sand	97	-859	956	66	145.0	62.4	82.6	46,950	46.950	86,433	46,950

Total Depth = *1012*

Intermediate Profile >>>> With excavation, soil is now over-consolidated.

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness (ft)*	*Average SPR (N_o)*	*Estimated Soil Unit Weight (pcf)*	*Unit Weight Water (pcf)*	*Effective Soil Unit Weight (kcf)*	*Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)*	*Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)*	*Intermediate Effective Vertical Stress at Bottom of Soil Layer (psf)*
3	Clay w/some silt, w/trace sand	101	97	4	42	145.0	0	145.0	290	0.290	580
4	Clay w/some silt, w/trace sand	97	-859	956	66	145.0	62.4	82.6	40,063	40.063	79,546

Waste Load U1 *B1 =* 795 *B2 =* 520 *Po =* 6,676 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	*α_1 (radians)*	*α_2 (radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
3	Clay w/some silt, w/trace sand	101	97	4	2	4	0.001	1.568	0.500	3,340
4	Clay w/some silt, w/trace sand	97	-859	956	482	960	0.194	1.026	0.483	3,222

Waste Load U2 *B1 =* 0.01 *B2 =* 695 *Po =* 5,751 *psf*

Cell 10, Point 2, pg 1/4

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
3	Clay w/some silt, w/trace sand	101	97	4	2.0	4.0	1.563	0.005	0.499	2,872
4	Clay w/some silt, w/trace sand	97	-859	956	482.0	960.0	0.964	0.000	0.307	1,766

Waste Load U3 B1 = 0.01 B2 = 105 Po = 1,124 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y 0	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
3	Clay w/some silt, w/trace sand	101	97	4	2.0	4.0	1.547	0.005	0.494	556
4	Clay w/some silt, w/trace sand	97	-859	956	482.0	960.0	0.214	0.000	0.068	77

Waste Load L1 B1 = 1285 B2 = 30 Po = 2,005 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
3	Clay w/some silt, w/trace sand	101	97	4	2	4	0.000	1.569	0.500	1003
4	Clay w/some silt, w/trace sand	97	-859	956	482	960	0.008	1.212	0.491	984

Waste Load L2 B1 = 0.01 B2 = 105 Po = 2,005 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
3	Clay w/some silt, w/trace sand	108	97	11	5.5	11	1.517	0.002	0.484	970
4	Clay w/some silt, w/trace sand	97	-859	956	489	967	0.212	0.000	0.067	135

Cell 10, Point 2, pg 3/4

Load Totals

Soil Layer	Soil Description	Load U1 (psf)	Load U2 (psf)	Load U3 (psf)	Load L1 (psf)	Load L2 (psf)	Increase in Effective Pressure (p') at Center of Soil Layer (psf)
3	Clay w/some silt, w/trace sand	3,340	(2,872)	556	1003	(970)	1,057
4	Clay w/some silt, w/trace sand	3,222	(1,766)	77	984	(135)	2,382

Final Profile

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)
3	Clay w/some silt, w/trace sand	108	97	11	145.0	0	145.0	290	1,057	1.057	1,347
4	Clay w/some silt, w/trace sand	97	-859	956	145.0	62.4	82.6	40,063	2,382	2.382	42,445

Elastic Settlement

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_o)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
3	Clay w/some silt, w/trace sand	11	42	22.9518	10,041	1.057	0.001	0.01
4	Clay w/some silt, w/trace sand	956	66	52.6254	23,024	2.382	0.099	1.19

Recompression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void Ratio e_o	Compression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
3	Clay w/some silt, w/trace sand	11	2.80	145.0	0.360	0.004	0.003	6,670	290	1347	0.02	0.26
4	Clay w/some silt, w/trace sand	956	2.80	145.0	0.360	0.004	0.003	46,950	40,063	42445	0.07	0.85

Cell 10, Point 2, pg 3/4

Compression Settlement - Cohesive Soils

Soil Layer	*Soil Description*	*Thickness (ft)*	*Specific Gravity*	*Estimated Unit Weight (pcf)*	*Initial Void Ratio* e_o	*Compression Index* C_c	*Corrected Compression Index* C_{cc}	*Effective Pre-consolidation Stress (* σ_p *') (psf)*	*Initial Effective Vertical Stress (* σ_{vo} *') at Center of Soil Layer (psf)*	*Final Effective Vertical Stress (* σ_{vf}*') at Center of Soil Layer (psf)*	*Calculated Compression Settlement (ft)*	*Calculated Compression Settlement (in)*
3	Clay w/some silt, w/trace sand	11	2.80	145.0	0.360	0.009	0.006	6,670	290	1,347	0.00	0.00
4	Clay w/some silt, w/trace sand	956	2.80	145.0	0.360	0.009	0.006	46,950	40,063	42,445	0.00	0.00

Summary

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness (ft)*	*Calculated Elastic Settlement (in)*	*Calculated Recompression Settlement (in)*	*Calculated Compression Settlement (in)*	*Total Calculated Settlement (in)*
3	Clay w/some silt, w/trace sand	108	97	11	0.01	0.26	0.00	0.27
4	Clay w/some silt, w/trace sand	97	-859	956	1.19	0.85	0.00	2.04
							Total	**2.32**

Cell 10, Point 2, pg 4/4

GENERAL SOIL PROFILE: CELL 10 **, POINT** 3 (NOT TO SCALE)

General Existing Profile (elev)	General Final Profile (elev)
Boring Profile: B-104 MW-18	240 (Top of landfill)
	3' Cap & Cover 105' CDD Waste 6' Liner & Leachate Collection System
TOG 136	126 (Floor of landfill)
Sand w/ trace fines Navg = 11	▽ 112
110	
Sand w/ trace fines Navg = 34 100	
clay to Silty clay Navg = 49 35	
Silty Clayey Sand to Silty Sand Navg = 74 5	
clay Navg = 70	

RECORD OF BOREHOLE B-104

SHEET 1 of 2

PROJECT: Chesapeake Terrace SFI
PROJECT NUMBER: 063-1431-003
DRILLED DEPTH: 100.0 ft
AZIMUTH: N/A
LOCATION: Odenton, MD

DRILL METHOD: Mud Rotary- 3 in.
DRILL RIG: Simco 2800
DATE STARTED: 4/22/13
DATE COMPLETED: 4/22/13
WEATHER: Partly Sunny

DATUM:
COORDS: N: 501,106.0 E: 1,386,593.8
GS ELEVATION: 109.9 ft
TOC ELEVATION: NA
TEMPERATURE: 55 F

INCLINATION: -90
DEPTH W.L.: NA

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE				SAMPLES					COMMENTS
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in	N	REC / ATT	
0		0.0 - 2.0 SAND; fine to medium, poorly graded, subrounded; lens of brown silty clay; yellowish brown; noncohesive; moist; compact.	SP	△ △	107.9	S1	DO	3-5-7-9	12	0.9 / 2.0	Sa
5	105	3.0 - 5.0 SAND; medium to coarse, poorly graded, subrounded; some nonplastic fines; reddish brown; noncohesive; moist to wet; very dense.	SP	△ △	104.9	S2	DO	26-27-27-30	54	1.3 / 2.0	Navg = 34
10	100	8.0 - 10.0 CLAYEY SAND; medium to coarse, poorly graded; some medium to coarse subrounded gravel; yellowish brown to dark grey; cohesive to noncohesive; moist; dense.	SC	▨	99.9	S3	DO	18-25-12-12	37	0.8 / 2.0	
15	95	13.0 - 15.0 CLAY; high plasticity; light grey mottled maroon, shiny; thinly laminated; cohesive; w>PL; stiff.	CH	▨	94.9	S4	DO	18-12-25-28	37	1.2 / 2.0	cl to SiCl
20	90	18.0 - 20.0 CLAY; high plasticity; light grey mottled maroon, shiny; thinly laminated; cohesive; w<PL; stiff.	CH	▨	89.9	S5	DO	10-12-25-28	37	1.3 / 2.0	Navg = 49 Clay possibly swelling in borehole.
25	85	23.0 - 25.0 SILTY CLAY; medium plasticity; lens of fine to medium yellow-brown sand, pockets of fine grey sand; light grey mottled dark red, slightly shiny; thinly laminated; cohesive; w<PL; stiff.	CL	▨	84.9	S6	DO	13-26-26-33	52	1.5 / 2.0	Clay swelled enough to close borehole and refuse rods- used 15' of 4'1/4" HSAs to support hole and resumed drilling and sampling through augers from 0-15 ft bgs.
30	80	28.0 - 30.0 SILTY CLAY; medium plasticity; trace of coarse angular gravel, pockets of fine yellowish brown sand; light grey mottled dark red, slightly shiny; thinly laminated; cohesive; w<PL; stiff.	CL	▨	79.9	S7	DO	10-12-24-24	36	1.2 / 2.0	
35	75	33.0 - 35.0 CLAY; medium to high plasticity; some nonplastic fines; dark red mottled light grey, shiny; cohesive; w~PL; stiff.	CH	▨	74.9	S8	DO	9-12-22-31	34	2.0 / 2.0	
40	70	38.0 - 40.0 SILTY CLAY; low to medium plasticity; trace fine sand, pockets of fine sand; brownish red mottled light grey, slightly shiny; slightly fissured; cohesive; w<PL; very stiff.	CL	▨	69.9	S9	DO	12-22-37-40	59	1.4 / 2.0	
45	65	43.0 - 45.0 SILTY CLAY; low to medium plasticity; trace fine sand; brownish red, slightly shiny; cohesive; w>PL; stiff.	CL	▨	64.9	S10	DO	12-26-35-45	61	2.0 / 2.0	
50	60	48.0 - 50.0 SILTY CLAY; low to medium plasticity; trace fine sand; brownish red, slightly shiny; cohesive; w>PL; stiff.	CL	▨	59.9	S11	DO	20-30-35-40	65	0.1 / 2.0	

Log continued on next page

LOG SCALE: 1 in = 6.5 ft
DRILLING COMPANY: Earth Matters Inc.
DRILLER: D. Taylor

GA INSPECTOR: KMC
CHECKED BY: VEF
DATE: 8/8/13

Golder Associates

RECORD OF BOREHOLE B-104

SHEET 2 of 2

PROJECT: Chesapeake Terrace SFI
PROJECT NUMBER: 063-1431-003
DRILLED DEPTH: 100.0 ft
AZIMUTH: N/A
LOCATION: Odenton, MD

DRILL METHOD: Mud Rotary- 3 in.
DRILL RIG: Simco 2800
DATE STARTED: 4/22/13
DATE COMPLETED: 4/22/13
WEATHER: Partly Sunny

DATUM:
COORDS: N: 501,106.0 E: 1,386,593.8
GS ELEVATION: 109.9 ft
TOC ELEVATION: NA
TEMPERATURE: 55 F

INCLINATION: -90
DEPTH W.L.: NA

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in	N	REC / ATT	COMMENTS
55	55	53.0 - 55.0 CLAY; high plasticity; purplish grey, mottled light grey, shiny; cohesive, w<PL, very stiff.	CH	▨	54.9	S12	DO	20 -20 -35 -40	55	1.1 / 2.0	
60	50	58.0 - 60.0 SILTY CLAY; medium plasticity; pockets of fine yellow-brown sand; mottled light grey and dark red; some yellow-brown staining; cohesive; w~PL; stiff. 58.8-59 ft: soft clay.	CL	▧	49.9	S13	DO	14 -30 -35 -42	65	1.0 / 2.0	
65	45	63.0 - 65.0 CLAY; medium to high plasticity; some nonplastic fines, trace fine sand, lens of fine to medium yellowish brown sand; dark red mottled grey, shiny; thinly laminated; cohesive; w~PL; very stiff.	CH	▨	44.9	S14	DO	12 -20 -30 -30	50	2.0 / 2.0	
70	40	68.0 - 70.0 SILTY CLAY; low to medium plasticity; some fine sand, pockets of fine grey sand; light grey mottled dark red, slightly shiny; cohesive; w<PL; very stiff.	CL	▧	39.9	S15	DO	13 -23 -31 -39	54	0.4 / 2.0	
75	35	73.0 - 75.0 SILTY CLAY and SAND; low to medium plasticity; fine, grey, poorly graded, subrounded sand; grey and reddish brown; cohesive; w~PL; stiff.	CL	▧	34.9	S16	DO	11 -17 -17 -50	34	1.7 / 2.0	
80	30	78.0 - 80.0 SILTY CLAY and SAND; low plasticity; fine, grey, poorly graded, subrounded sand, lenses of grey clay, lenses of fine to medium grey sand; light grey; cohesive; w~PL; firm.	CL	▧	29.9	S17	DO	16 -22 -25 -50/5"	47	1.9 / 2.0	
85	25	83.0 - 85.0 CLAYEY SILTY SAND; fine, poorly graded, subrounded; lenses of grey clay, lenses of fine to medium grey sand; noncohesive; moist to wet; dense.	SM	▽	24.9	S18	DO	31 -17 -33 -50/3"	50	1.8 / 2.0	Drilled w/o sampling. (84.6'-86')
90	20	88.0 - 90.0 SILTY SAND; fine to medium, poorly graded, subrounded; some plastic fines, lens of grey clay; light grey; noncohesive; moist; very dense.	SM	▽	19.9	S19	DO	27 -43 -50/3"	100+ N/A	1.0 / 2.0	Drilled w/o sampling. (89.3'-90')
95	15	93.0 - 95.0 SILTY SAND; fine to medium, well graded, subrounded; lens of soft dark red clay; light grey; trace thin, black, soft, shiny material: possibly coal; noncohesive; moist to wet; very dense.	SM	▽	14.9	S20	DO	50/5"	100+ N/A	0.5 / 2.0	Drilled w/o sampling. (93.4'-95')
100	10	98.0 - 100.0 CLAY; medium to high plasticity; some nonplastic fines, seams of fine dark grey sand; dark grey, shiny; cohesive; w<PL; very stiff. Boring completed at 100.0 ft	CH	▨	9.9	S21	DO	16 -35 -35 -40	70	2.0 / 2.0	

Si Cl & Sa
to
Si Sa
Navg = 74

Cl
Navg = 70

LOG SCALE: 1 in = 6.5 ft
DRILLING COMPANY: Earth Matters Inc.
DRILLER: D. Taylor

GA INSPECTOR: KMC
CHECKED BY: VEF
DATE: 8/8/13

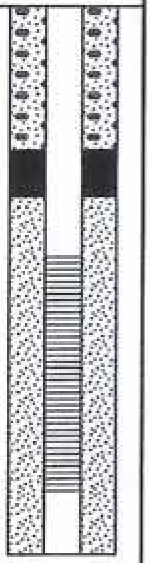
MW-18

Chesapeake Terrace

Client	National Waste Managers	Drill Rig	Hollow Stem
Geologist	Mark Schultz	Ground Elevation	126 Feet
Date Drilled	4-8-03	Total Depth of Borehole	23 Feet
Borehole Diameter	8 Inches	Depth to Water	11.24 Feet

Graphic Log	Description	Depth	Sample	Recovery (in)	Blow Counts
▩	Sand, med-crs, tr fines, yellow-brn-tan, moist to wet	5	☒	14	⑨ 3-5-4-5
▩	Navg = 11	10	☒	15	⑬ 4-5-8-10
▩		15	☒	17	⑨ 3-4-5-7
▩		20	☒	18	⑫ 3-5-7-9
▨	Clay, tr silt, maroon and gray mottled, plastic, moist to wet Navg = 18	25	☒	16	⑱ 6-8-10-30
		30			
		35			
		40			
		45			

Completion

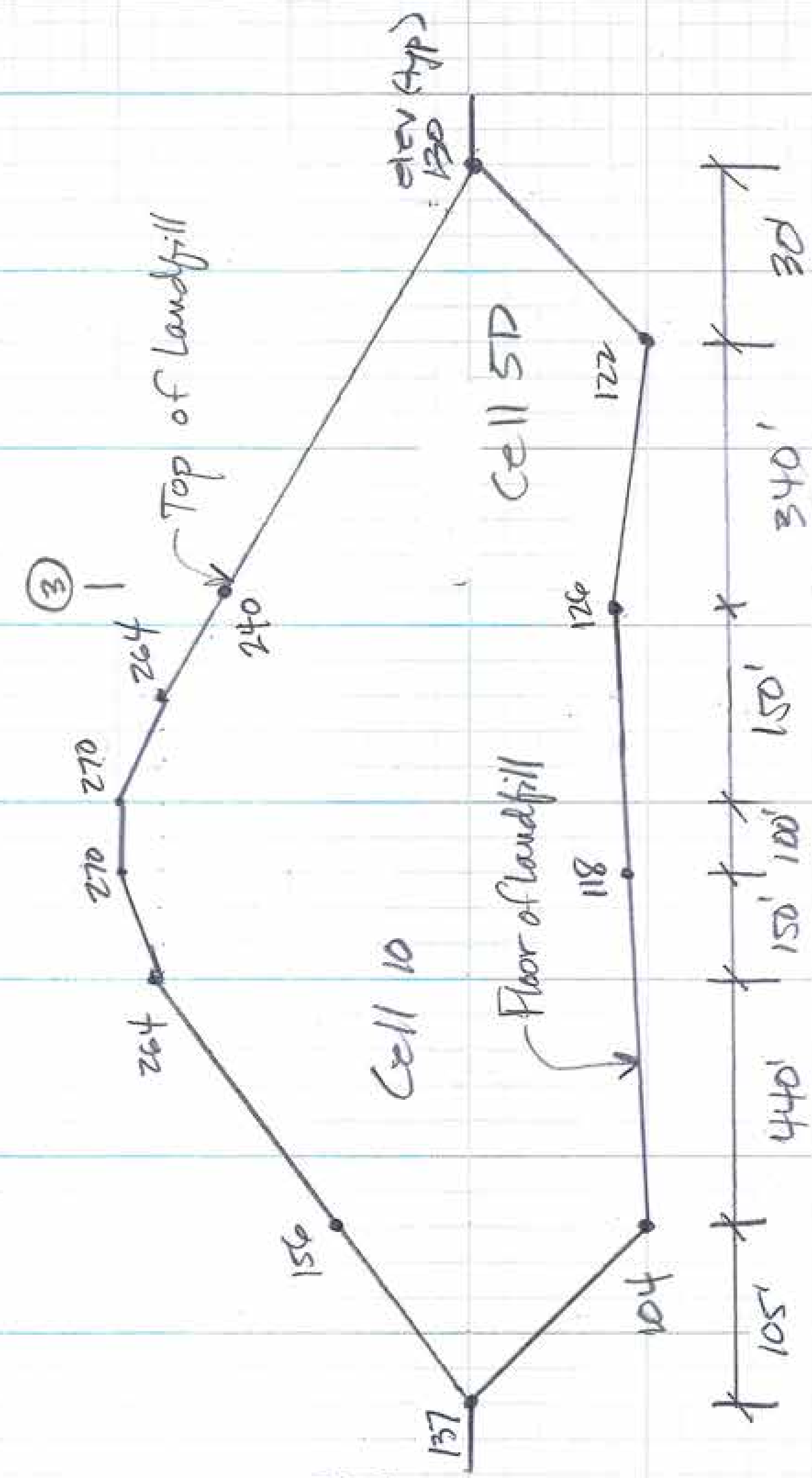


Notes:

C:\Program Files\Popular Media\Well Logger 2.7\Chesapeake Terrace\April 2003 Drilling Program.wl2

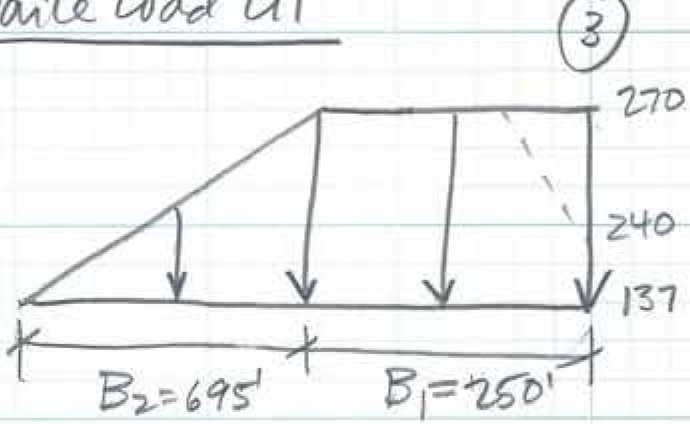
Mark Schultz Associates

APPROXIMATE SECTION



SHEET 1 OF 1	PROJECT NO. 2018-3084	PROJECT NAME Chester	
BY JCA	DATE 7/5/20	DESCRIPTION Cell 10, Point 3 Settlement	
CHK. BY	DATE		

Waste Load U1



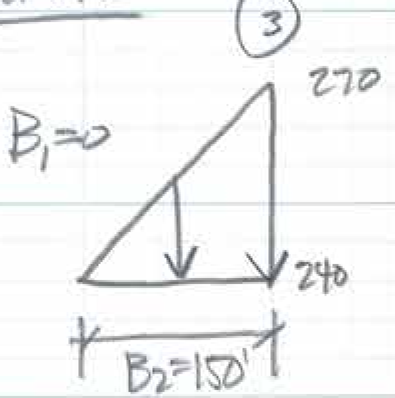
$H_{CDD} = 270-137-3 = 130'$

$p = \Sigma(\gamma H)$

$= (3)(115) + (130)(48.7)$

$= 6676$ psf

Waste Load U2

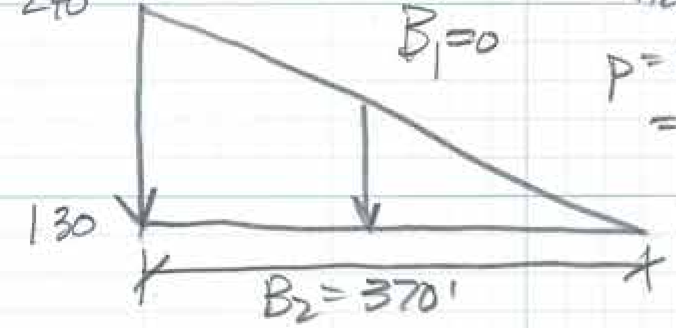


$H_{CDD} = 270-240-3 = 27'$

$p = \Sigma(\gamma H) = (3)(115) + (27)(48.7)$

$= 1660$ psf

Waste Load U3



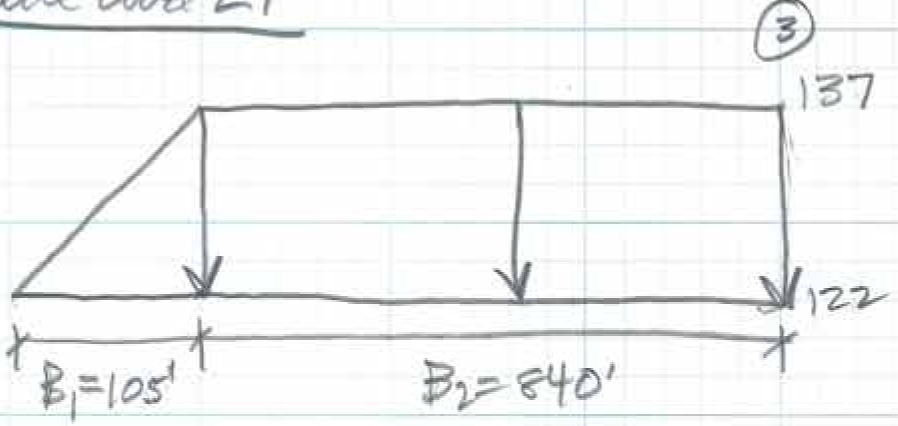
$H_{CDD} = 240-130-3 = 107'$

$p = \Sigma(\gamma H) = (3)(115) + (107)(487)$

$= 5556$ psf

SHEET 1 OF 2 PROJECT NO. 2018-3081 PROJECT NAME
BY JCA DATE 7/6/20 DESCRIPTION Cell 10, Point 3 Settlement
CHK. BY DATE

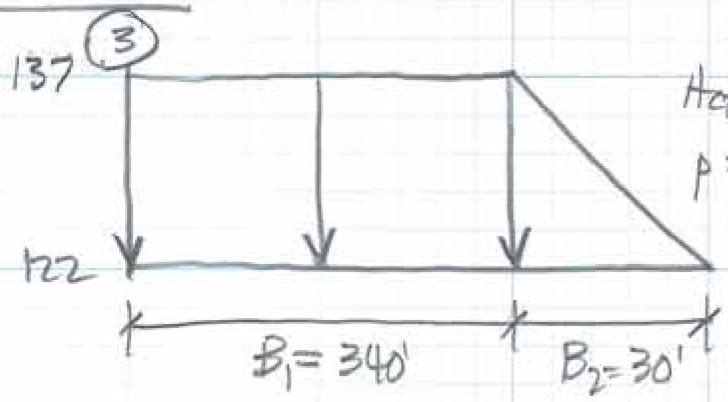
Waste Load L_1



$H_{CDD} = 137 - 122 - 6 = 9'$

$p = \Sigma_1^i (\gamma H) = (6)(115) + (9)(48.7) = 1128$ psf

Waste Load L_2



$H_{CDD} = 137 - 122 - 6 = 9'$

$p = \Sigma_1^i (\gamma H) = (9)(48.7) + (6)(115)$
$= 1128$ psf

Net load = $U_1 - U_2 + U_3 + L_1 + L_2$

SHEET 2 OF 2 PROJECT NO. 2018-3084 PROJECT NAME

BY JKA DATE 7/6/20 DESCRIPTION Cell 10, Point 3 Settlement

CHK. BY DATE

Cell 10 **Point** 3
Boring Profile: B-104, MW-18

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Initial Effective Vertical Stress at Bottom of Soil Layer (psf)	Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)
1	Sand w/trace fines	136	112	24	11	117.7	0	117.7	1,413	1.413	2,826	1,413
2	Sand w/trace fines	112	110	2	11	117.7	62.4	55.3	2,881	2.881	2,936	2,881
3	Sand w/trace fines	110	100	10	34	131.5	62.4	69.1	3,282	3.282	3,627	3,282
4	Clay to Clayey Silt	100	35	65	49	145.0	62.4	82.6	6,312	6.312	8,996	6,312
5	Silty Clayey Sand to Silty Sand	35	5	30	74	145.0	62.4	82.6	10,235	10.235	11,474	10,235
6	Clay	5	-834	839	70	145.0	62.4	82.6	46,125	46.125	80,775	46,125
			Total Depth =	*970*								

Interimediate Profile >>>> With excavation, soil is now over-consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Intermediate Effective Vertical Stress at Bottom of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	11	117.7	0	117.7	824	0.824	1,648
2	Sand w/trace fines	112	110	2	11	117.7	62.4	55.3	1,704	1.704	1,759
3	Sand w/trace fines	110	100	10	34	131.5	62.4	69.1	2,104	2.104	2,450
4	Clay to Clayey Silt	100	35	65	49	145.0	62.4	82.6	5,134	5.134	7,819
5	Silty Clayey Sand to Silty Sand	35	5	30	74	145.0	62.4	82.6	9,058	9.058	10,297
6	Clay	5	-834	839	70	145.0	62.4	82.6	44,947	44.947	79,598

Waste Load U1 *400* 695 *540* 250 *Po =* 6,676 *psf*

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	7	14	0.003	1.562	0.500	3,340
2	Sand w/trace fines	112	110	2	15	16	0.007	1.552	0.500	3,340
3	Sand w/trace fines	110	100	10	21	26	0.010	1.544	0.500	3,340
4	Clay to Clayey Silt	100	35	65	58.5	91	0.029	1.497	0.500	3,339
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.052	1.438	0.500	3,338
6	Clay	5	-834	839	540.5	960	0.207	0.974	0.477	3,184

Cell 10, Point 3, pg 1/4

Waste Load U2 B1 = 0.01 B2 = 150 Po = 1,660 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	7	14	0.003	1.562	0.500	830
2	Sand w/trace fines	112	110	2	15	16	0.007	1.552	0.500	830
3	Sand w/trace fines	110	100	10	21	26	0.010	1.544	0.500	830
4	Clay to Clayey Silt	100	35	65	58.5	91	0.029	1.497	0.500	830
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.052	1.438	0.500	830
6	Clay	5	-834	839	540.5	960	0.207	0.974	0.477	792

Waste Load U3 B1 = 0.01 B2 = 370 Po = 5,556 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	7	14	0.003	1.562	0.500	2,779
2	Sand w/trace fines	112	110	2	15	16	0.007	1.552	0.500	2,779
3	Sand w/trace fines	110	100	10	21	26	0.010	1.544	0.500	2,779
4	Clay to Clayey Silt	100	35	65	58.5	91	0.029	1.497	0.500	2,779
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.052	1.438	0.500	2,778
6	Clay	5	-834	839	540.5	960	0.207	0.974	0.477	2,650

Waste Load L1 B1 = 105 B2 = 840 Po = 1,128 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	7	14	0.000	1.565	0.500	564
2	Sand w/trace fines	112	110	2	15	16	0.000	1.559	0.500	564
3	Sand w/trace fines	110	100	10	21	26	0.000	1.554	0.500	564
4	Clay to Clayey Silt	100	35	65	58.5	91	0.001	1.525	0.500	564
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.002	1.488	0.500	564
6	Clay	5	-834	839	540.5	960	0.008	1.173	0.488	550

Cell 10, Point 3, pg 2/4

Waste Load L2

B1 = 340

B2 = 30

Po = 1,128 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	7	14	0.000	1.565	0.500	564
2	Sand w/trace fines	112	110	2	15	16	0.000	1.559	0.500	564
3	Sand w/trace fines	110	100	10	21	26	0.000	1.554	0.500	564
4	Clay to Clayey Silt	100	35	65	58.5	91	0.001	1.525	0.500	564
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.002	1.488	0.500	564
6	Clay	5	-834	839	540.5	960	0.008	1.173	0.488	550

Load Totals

Soil Layer	Soil Description	Waste Load U1 (psf)	Waste Load U2 (psf)	Waste Load U3 (psf)	Waste Load L1 (psf)	Waste Load L2 (psf)	Total Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
1	Sand w/trace fines	3,340	(830)	2,779	564	564	6,417
2	Sand w/trace fines	3,340	(830)	2,779	564	564	6,417
3	Sand w/trace fines	3,340	(830)	2,779	564	564	6,417
4	Clay to Clayey Silt	3,339	(830)	2,779	564	564	6,417
5	Silty Clayey Sand to Silty Sand	3,338	(830)	2,778	564	564	6,414
6	Clay	3,184	(792)	2,650	550	550	6,142

Final Profile

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (ksf)	Final Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	11	117.7	0.0	117.7	824	6,417	6.417	7,241
2	Sand w/trace fines	112	110	2	11	117.7	62.4	55.3	1,704	6,417	6.417	8,121
3	Sand w/trace fines	110	100	10	34	131.5	62.4	69.1	2,104	6,417	6.417	8,522
4	Clay to Clayey Silt	100	35	65	49	145.0	62.4	82.6	5,134	6,417	6.417	11,551
5	Silty Clayey Sand to Silty Sand	35	5	30	74	145.0	62.4	82.6	9,058	6,414	6.414	15,472
6	Clay	5	-834	839	70	145.0	62.4	82.6	44,947	6,142	6.142	51,089

Cell 10, Point 3, pg 3/4

Elastic Settlement

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_o)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
1	Sand w/trace fines	14	11		176.00	6.417	0.51	6.13
2	Sand w/trace fines	2	11		176.00	6.417	0.07	0.88
3	Sand w/trace fines	10	34		544.00	6.417	0.12	1.42
4	Clay to Clayey Silt	65	49	30.3452	13,276.03	6.417	0.03	0.38
5	Silty Clayey Sand to Silty Sand	30	74		1,184.00	6.414	0.16	1.95
6	Clay	839	70	58.7582	25,706.71	6.142	0.20	2.41

Recompression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Recompression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Interim Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
1	Sand w/trace fines	14	2.65	117.7								
2	Sand w/trace fines	2	2.65	117.7								
3	Sand w/trace fines	10	2.65	131.5								
4	Clay to Clayey Silt	65	2.80	145.0	0.360	0.009					0.00	0.00
5	Silty Clayey Sand to Silty Sand	30	2.65	145.0								
6	Clay	839	2.80	145.0	0.360	0.009					0.00	0.00

Compression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
1	Sand w/trace fines	14	2.65	117.7								
2	Sand w/trace fines	2	2.65	117.7								
3	Sand w/trace fines	10	2.65	131.5								
4	Clay to Clayey Silt	65	2.80	145.0	0.360	0.009					0.00	0.00
5	Silty Clayey Sand to Silty Sand	30	2.65	145.0								
6	Clay	839	2.80	145.0	0.360	0.009					0.00	0.00

Summary

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Total Calculated Settlement (in)
1	Sand w/trace fines	14	2.65	117.7	6.13	0.00	0.00	6.13
2	Sand w/trace fines	2	2.65	117.7	0.88	0.00	0.00	0.88
3	Sand w/trace fines	10	2.65	131.5	1.42	0.00	0.00	1.42
4	Clay to Clayey Silt	65	2.80	145.0	0.38	0.00	0.00	0.38
5	Silty Clayey Sand to Silty Sand	30	2.65	145.0	1.95	0.00	0.00	1.95
6	Clay	839	2.80	145.0	2.41	0.00	0.00	2.41
			Totals		**13.15**	**0.00**	**0.00**	**13.15**

Cell 10, Point 3, pg 4/4

GENERAL SOIL PROFILE: CELL 10**, POINT** 4 (NOT TO SCALE)

General Existing Profile (elev)	General Final Profile (elev)
	270 (Top of Landfill)
Boring Profile: B-30	3' cap & cover 144' CDD Waste 6' Liner & Leachate collection system 118 (Floor of Landfill)
TOG 116	2' fill Navg=40
Sand w/ trace fines Navg= 37 101	▽ 110
Clay w/ trace silt to Clay Navg = 58 56	

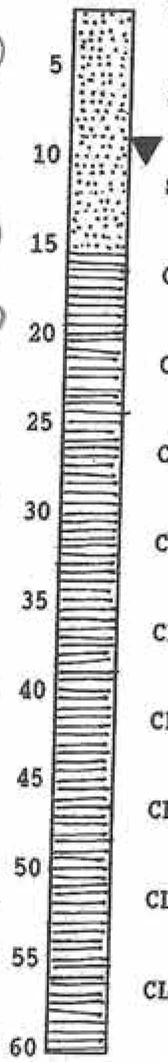
GS EL. 116±

BORING NUMBER: B-30

DATE INSTALLED: 4-25-91
PROJECT: CHESAPEAKE RUBBLE FILL
SAMPLE METHOD: SPLIT SPOON
LOGGED BY: MARK SCHULTZ
DRILLING METHOD: HOLLOW STEM AUGER AND MUD
DRILLER: HARDIN-HUBER, INC

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches) Ⓝ	Description
1	0 - 2	2-3-4-5 ⑦ (10)	SAND, med, little fn, tr clay, yellow-brown, moist
2	5 - 7	15-23-25-30 ㊽ (15)	SAND, as above
3	Navg=37 10-12	9-24-32-30 (56) (24)	SAND, med, little fn and little clay, yellow-brown, wet[a]
4	15-17	11-17-23-28 ㊵ (22)	CLAY, tr silt, red, moist
5	20-22	10-18-22-26 ㊵ (24)	CLAY, tr silt, gray-purple, moist
6	25-27	9-15-22-30 ㊲ (24)	CLAY, tr silt, red-gray, moist
7	30-32	15-17-19-25 ㊱ (24)	CLAY, tr silt, gray w/red, moist
8	Navg=58 35-37	10-14-18-20 ㉜ (20)	CLAY, tr silt, red w/gray mottles, slightly moist
9	40-42	30-45-70 (100+) (18)	CLAY (no silt), gray w/red mottles, slightly moist
10	45-47	50-60-65 (100+) (18)	CLAY, brown-red, slightly moist
11	50-52	14-35-45-51/5 (80) (18)	CLAY, brown, slightly moist
12	55-57	8-20-35-45 (55) (20)	CLAY, brown w/red, slight to tr moist

Graphic Log



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a. Rods wet at 10 feet.

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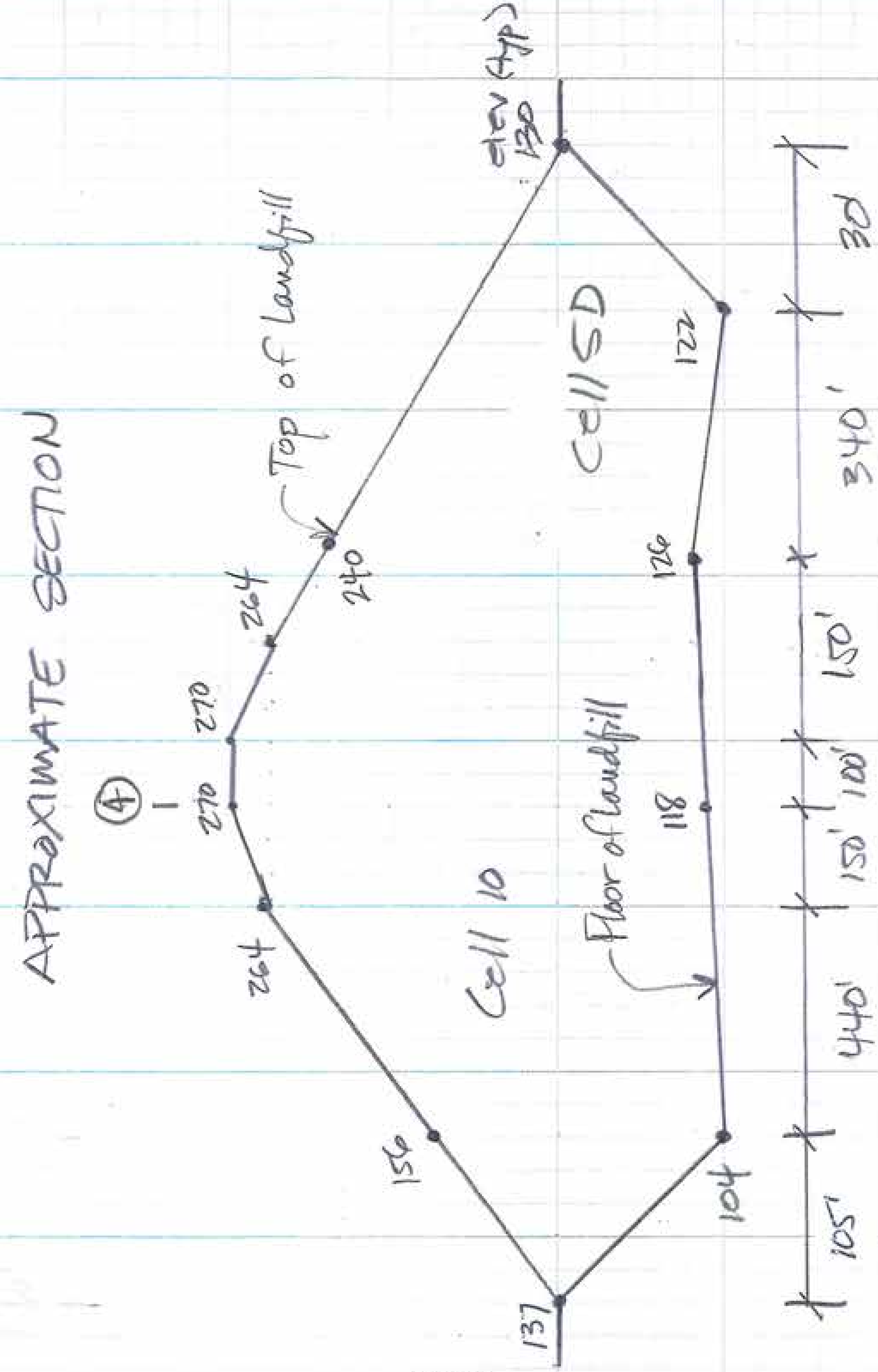
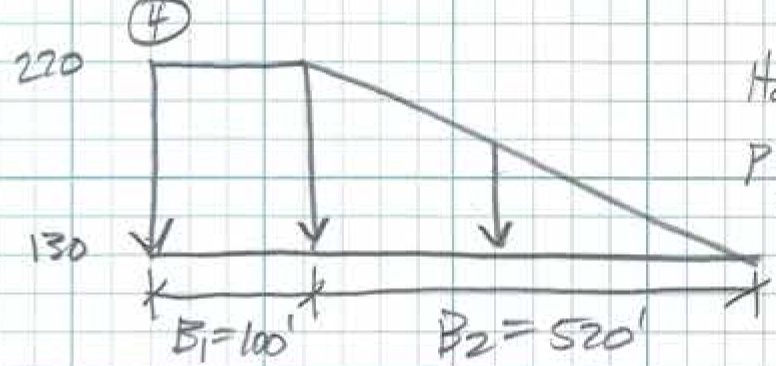


SHEET 1 OF 1 PROJECT NO. 2018-3084 PROJECT NAME Ches Ter

BY JCA DATE 7/5/20 DESCRIPTION Cell 10, Point 4 Settlement

CHK. BY DATE

Waite Load U1



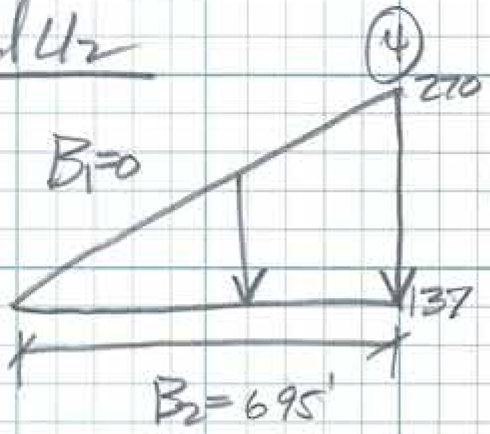
$H_{CDD} = 270 - 130 - 3 = 137'$

$p = \Sigma_i(\gamma H)$

$= 3(115) + (137)(48.7)$

$= 7017$ psf

Waite Load U2



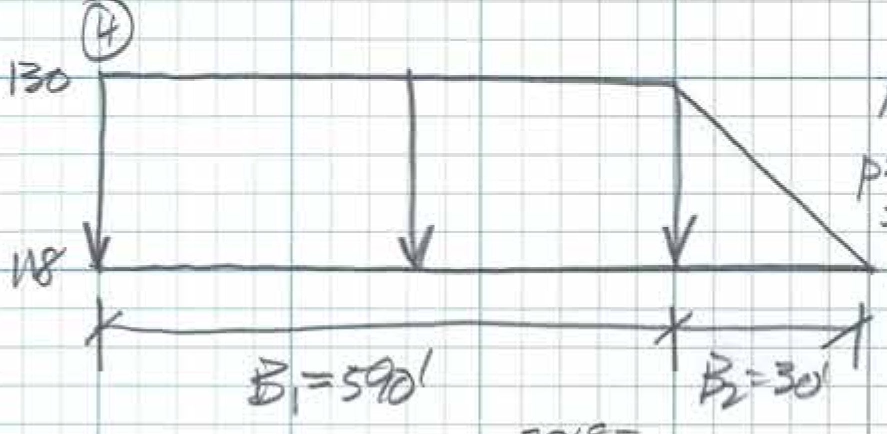
$H_{CDD} = 270 - 137 - 3 = 130$

$p = \Sigma_i(\gamma H)$

$= (3)(115) + (130)(48.7)$

$= 6676$ psf

Waite Load L1



$H_{CDD} = 130 - 118 - 6 = 6$

$p = \Sigma_i(\gamma H)$

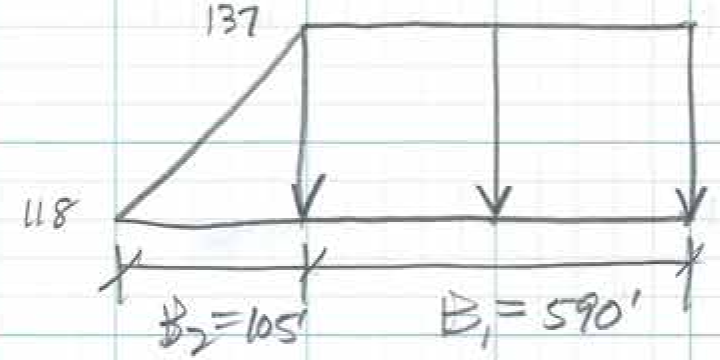
$= (6)(48.7) + (6)(115)$

$= 982$ psf

SHEET 1 OF 2 PROJECT NO. 2018-3084 PROJECT NAME
BY JCA DATE 7/7/20 DESCRIPTION Cell 14, Point 4 Settlement
CHK. BY DATE

Waste Load L_2

④



$H_{CDD} = 137 - 118 - 6 = 13'$

$p = \Sigma (\gamma H)$
$= (13)(48.7) + (6)(115)$
$= 1323$ psf

Net load $= U_1 + U_2 + L_1 + L_2$

2018-
SHEET 2 OF 2 PROJECT NO. 3084 PROJECT NAME
BY JCA DATE 7/7/20 DESCRIPTION Cell 10, Point 4 Settlement
CHK. BY DATE

Cell 10 **Point** 4

Boring Profile: B-30

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_o)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Initial Effective Vertical Stress at Bottom of Soil Layer (psf)	Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)
1	Sand w/trace fines	116	110	6	37	121.7	0	121.7	365	0.365	730	365
2	Sand w/trace fines	110	101	9	37	121.7	62.4	59.3	997	0.997	1,264	997
3	Clay w/trace silt to Clay	101	-844	945	58	145.0	62.4	82.6	40,293	40.293	79,321	40,293
			Total Depth =	*960*								

Intermediate Profile >>>> With a thin layer of fill, soil is still normally consolidated. Assume fill will be a sandy material, and will be compacted to a density (i.e., blow count) similar as that of the soil below. Fill adds (2 ft)(121.7 pcf) = 243 psf to vertical stress in underlying soil layers

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_o)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)
1	Sand w/trace fines	116	110	6	37	121.7	0	121.7	365	243	0.243	608
2	Sand w/trace fines	110	101	9	37	121.7	62.4	59.3	997	243	0.243	1,240
3	Clay w/trace silt to Clay	101	-844	945	58	145.0	62.4	82.6	40,293	243	0.243	40,536

Elastic Settlement
Due to Fill

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_o)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
1	Sand w/trace fines	6	37		592	0.243	0.0025	0.030
2	Sand w/trace fines	9	37		592	0.243	0.0037	0.044
3	Clay w/trace silt to Clay	945	58	41.4	7,758	0.243	0.0296	0.355

Recompression Settlement - Cohesive Soils
Due to Fill

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Recompression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
3	Clay w/trace silt to Clay	945	2.80	145.0	0.360							

Cell 10, Point 4, pg 1/4

Compression Settlement - Cohesive Soils
Due to Fill

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Intermediate Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
3	Clay w/trace silt to Clay	945	2.80	145.0	0.360	0.009	0.006	40,293	40,293	40,536	0.016	0.19

Waste Load U1

B1 = 100

B2 = 520

Po = 7,017 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
F	Sand w/trace fines	118	116	2	1	2	0.000	1.570	0.500	3,510
1	Sand w/trace fines	116	110	6	5	8	0.002	1.565	0.500	3,510
2	Sand w/trace fines	110	101	9	12.5	15	0.006	1.555	0.500	3,510
3	Clay w/trace silt to Clay	101	-844	945	487.5	954	0.195	1.021	0.482	3,383

Waste Load U2

B1 = 0.01

B2 = 695

Po = 6,676 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
F	Sand w/trace fines	118	116	2	1	2	0.000	1.570	0.500	3,340
1	Sand w/trace fines	116	110	6	5	8	0.002	1.565	0.500	3,340
2	Sand w/trace fines	110	101	9	12.5	15	0.006	1.555	0.500	3,340
3	Clay w/trace silt to Clay	101	-844	945	487.5	954	0.195	1.021	0.482	3,219

Cell 10, Point 4, pg 3/4

Waste Load L1

B1 = 590 *B2 =* 30 *Po =* 982 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	*α_1 (radians)*	*α_2 (radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
F	Sand w/trace fines	118	116	2	1	2	0.000	1.570	0.500	491
1	Sand w/trace fines	116	110	6	5	8	0.000	1.567	0.500	491
2	Sand w/trace fines	110	101	9	12.5	15	0.000	1.561	0.500	491
3	Clay w/trace silt to Clay	101	-844	945	487.5	954	0.008	1.208	0.491	482

Waste Load L2

B1 = 590 *B2 =* 105 *Po =* 1,323 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	*α_1 (radians)*	*α_2 (radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
F	Sand w/trace fines	118	116	2	1	2	0.000	1.570	0.500	662
1	Sand w/trace fines	116	110	6	5	8	0.000	1.567	0.500	662
2	Sand w/trace fines	110	101	9	12.5	15	0.000	1.561	0.500	662
3	Clay w/trace silt to Clay	101	-844	945	487.5	954	0.008	1.208	0.491	649

Load Totals

Soil Layer	*Soil Description*	*Waste Load U1 (psf)*	*Waste Load U2 (psf)*	*Waste Load L1 (psf)*	*Waste Load L2 (psf)*	*Total Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*
F	Sand w/trace fines	3,510	3,340	491	662	8,003
1	Sand w/trace fines	3,510	3,340	491	662	8,003
2	Sand w/trace fines	3,510	3,340	491	662	8,003
3	Clay w/trace silt to Clay	3,383	3,219	482	649	7,733

Final Profile >>>> Includes the fill layer; reflects vertical stress due to fill layer on soil layers below.

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness (ft)*	*Average SPR (N_a)*	*Estimated Unit Weight (pcf)*	*Unit Weight Water (pcf)*	*Effective Unit Weight (pcf)*	*Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (ksf)*	*Final Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)*
F	Sand w/trace fines (Fill)	118	116	2	37	121.7	0	121.7	122	8,003	8.003	8,125
1	Sand w/trace fines	116	110	6	37	121.7	0	121.7	365	8,003	8.003	8,368
2	Sand w/trace fines	110	101	9	37	121.7	62.4	59.3	997	8,003	8.003	9,001
3	Clay w/trace silt to Clay	101	-844	945	58	145.0	62.4	82.6	40,293	7,733	7.733	48,026

Cell 10, Point 4, pg 3/4

Elastic Settlement
Due to Waste

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_a)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
F	Sand w/trace fines (Fill)	2	37		592	8.003	0.03	0.32
1	Sand w/trace fines	6	37		592	8.003	0.08	0.97
2	Sand w/trace fines	9	37		592	8.003	0.12	1.46
3	Clay w/trace silt to Clay	945	58	41.4	7,758	7.733	0.94	11.30

Recompression Settlement - Cohesive Soils
Due to Waste

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Recompression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
3	Clay w/trace silt to Clay	945	2.80	145.0				40,293	40,293		0.00	0.00

Compression Settlement - Cohesive Soils
Due to Waste

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
3	Clay w/trace silt to Clay	945	2.80	145.0	0.360	0.009	0.006	40,293	40,293	48,026	0.45	5.46

Summary

					Due to Fill			Due to Waste			
Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Total Calculated Settlement (in)
F	Sand w/trace fines (Fill)	118	116	2				0.32			0.32
1	Sand w/trace fines	116	110	6	0.03			0.97			1.00
2	Sand w/trace fines	110	101	9	0.04			1.46			1.50
3	Clay w/trace silt to Clay	101	-844	945	0.36		0.19	11.30		5.46	17.30
			Totals		**0.43**	**0.00**	**0.19**	**14.06**	**0.00**	**5.46**	**20.13**

Cell 10, Point 4, pg 4/4

GENERAL SOIL PROFILE: CELL 13 **, POINT** 1 (NOT TO SCALE)

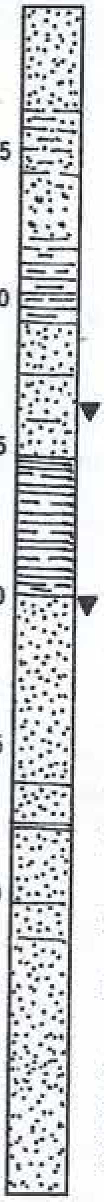
General Existing Profile (elev)	General Final Profile (elev)
Boring Profile: B-13	
90	87 (Edge of Landfill)
Sand w/ silt & clay Navg = 5 85	
Silt w/ sand, some gravel Navg = 29 81	
Clay w/ silt lenses Navg = 21 79	
Sand w/ clay lenses Navg = 53 75	
Clay w/ sand & silt Navg = 28 70	▽ 71.
Sand w/ thin clay layers Navg = 81 35	
Clay w/ little silt & trace sand Navg = 97 20	

BORING NUMBER: B-13 TOP OF GROUND ≈ 83.0

MONITOR WELLS: MW-3

DATE INSTALLED: 7-18-89
PROJECT: CHESAPEAKE RUBBLE FILL
SAMPLE METHOD: SPLIT SPOON **DRILLING METHOD:** HOLLOW STEM AUGER
LOGGED BY: GREG ADAMSON **DRILLER:** HARDIN-HUBER, INC

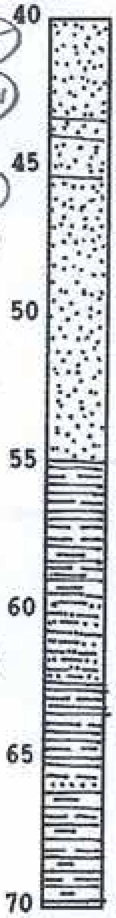
↓ Ⓝ

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	Graphic Log	Description
1	0 - 2	2-2-2-2 ④ (18)		SAND, med, some v fn, tr silt and clay, yellow
2	2.5-4.5	2-2-3-4 ⑤ (24)		SILT and fn SAND, tr clay, brown
3	5 - 7 5'	2-12-17-22 ㉙ (15)		2" SILT and fn SAND, as above 9" GRAVEL, little coarse sand, yellow
4	7.5-9.5 9'	15-11-11-15 ㉒ (19)		CLAY, little silt, with lenses of SILT, gray
5	10-12 11'	8-8-12-14 ⑳ (12)		6" CLAY, as above 6" SAND, med, some fn, yellow
6	12.5-14.5	17-34-51-51/5" (16) (85)		SAND, as above with thin CLAY lenses, gray, <u>saturated</u>
7	15-17 15'	12-12-14-22 ㉖ (24)		CLAY, little fn sand and silt, gray
8	17.5-19.5	7-12-17-17 ㉙ (19)		CLAY, little vf sand and silt, gray
9	20-22 20'	30-51/7" (100+) (9)		SAND, med, little fn, tr silt and clay, gray-yellow, <u>saturated</u>
10	22.5-24.5	(85) 32-34-51/5" (18)		SAND, as above
11	25-27	(85) 22-34-51/5" (18)		SAND, as above, clay stringers in lower 11"
12	27.5-29.5	(86) 17-35-51/5" (18)		SAND, as above, with 3" CLAY layer
13	30-32	(84) 9-13-51/5" (18)		SAND, as above, some thin lenses of clay, gray
14	32.5-37.5	40-51/3" (100) (0)		No recovery
15	35-37	(76) 13-25-51/5" (18)		SAND, vf to med, tr silt and clay, yellow-gray, saturated and CLAY layers 2 and 4" thick
16	37.5-39.5	17-28-40-51/5" (64)		SAND, med, some fine, tr silt, lt tan, (24) saturated, with a 2" CLAY layer

BORING NUMBER: B-13 continued

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	N	Description
17	40-42	17-24-51/5" (18)	75	SAND, med and fn, little vf, tr silt and clay, few thin clay lenses, lt tan-gray
18	42.5-44.5	10-30-51/5" (18)	81	SAND, med and fn, little vf, tr silt, few thin clay lenses, tan, saturated
19	45-47	12-30-51/6" (18)	81	SAND, as above
20	47.5-49.5	45-51/2" (12)	100	SAND, as above, no clay lenses
21	50-52	45-51/6" (12)	100	SAND, as above
22	52.5-54.5	51/4" (4)	100	SAND, as above
	55'			
23	55-57	25-51/5" (10)	100	CLAY, little silt, tr sand, mottled red-gray
24	57.5-59.5	51/5" (6)	100	SILT and CLAY, some sand, gray
25	60-62	28-46-51/2" (14)	97	SILT and vf SAND, little clay, gray
26	62.5-64.5	18-31-51/5" (17)	82	CLAY, some silt, tr sand, gray
27	65-67	31-51/5" (11)	100	7" CLAY, as above 2" SAND, vf, little silt, gray 2" CLAY and SILT, tr sand, brown-gray
28	67.5-69.5	45-51/5" (12)	100	CLAY and SILT, some sand, gray

Graphic Log



Groundwater encountered at 14 feet.

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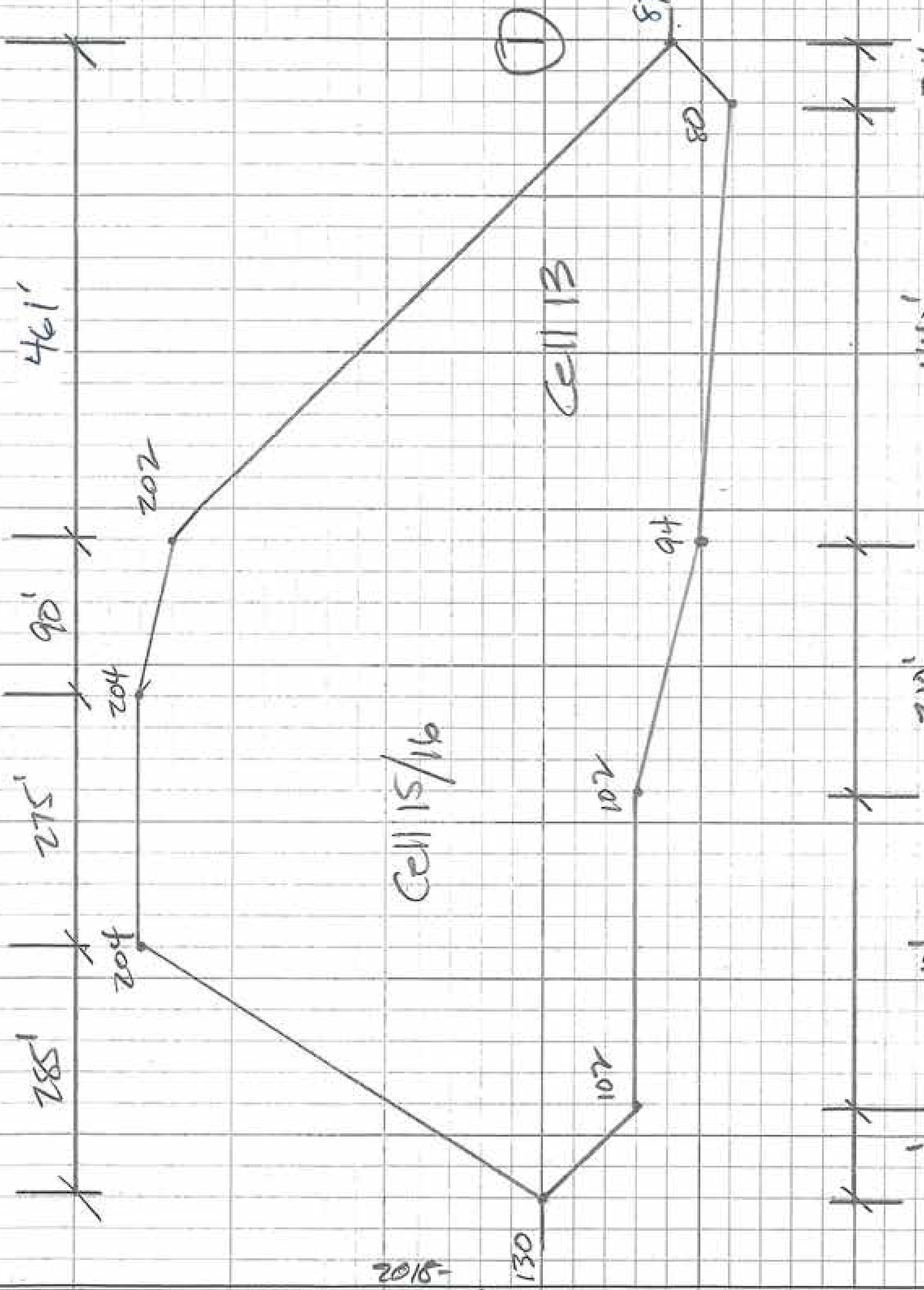


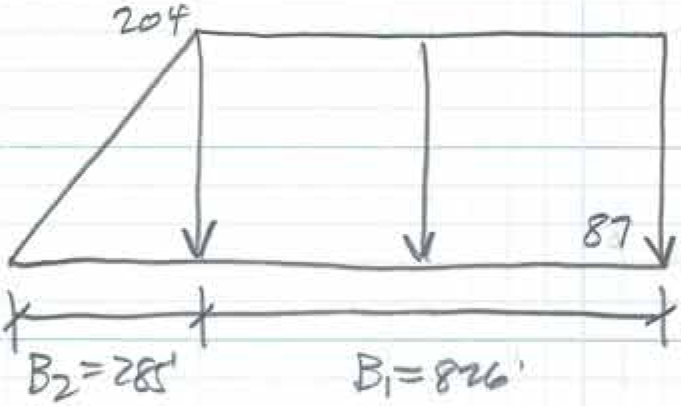
SHEET 1 OF 1 PROJECT NO. 2015- 3054 PROJECT NAME

BY JCA DATE 7/11/20 DESCRIPTION Cell 13, Point 1 Settlement

CHK. BY DATE

Waste Load U_1

①



$H_{CDD} = 204 - 87 - 3 = 114$

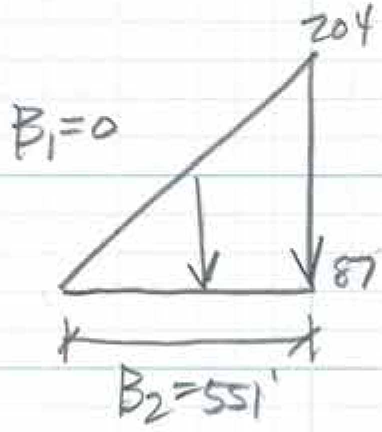
$p = \Sigma'(\gamma H)$

$= (3)(115) + (114)(48.7)$

$= 5897$ psf

Waste Load U_2

①



$H_{CDD} = 204 - 87 - 3 = 114'$

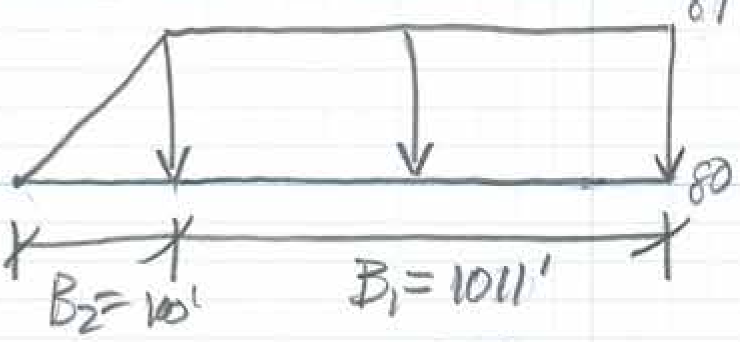
$p = \Sigma'(\gamma H)$

$= (3)(115) + (114)(48.7)$

$= 5897$ psf

Waste Load L_1

①



$H_{CDD} = 87 - 80 - 6 = 1$

$p = \Sigma'(\gamma H)$

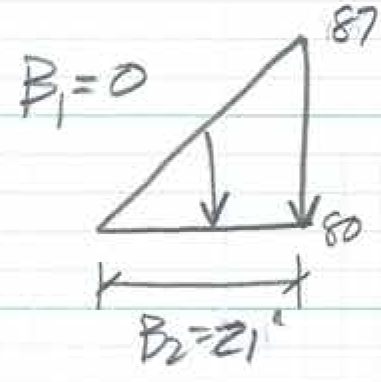
$= (1)(48.7) + (6)(115)$

$= 739$ psf

SHEET 1 OF 2 PROJECT NO. 2015-3084 PROJECT NAME
BY JKA DATE 7/11/20 DESCRIPTION Cell 13, Point 1 Settlement
CHK. BY DATE

Waste Load L_2

①



$H_{CDD} = 87-80-6 = 1$

$p = \Sigma(\gamma H)$

$= (1)(48.7)+(6)(115)$

$= 739$ psf

Net load $= U_1 - U_2 + L_1 - L_2$

SHEET 2 OF 2 PROJECT NO. 2018-3084 PROJECT NAME
BY VCA DATE 7/11/20 DESCRIPTION Cell 13, Point 1 Settlement
CHK. BY DATE

Settlement Analysis

Cell 13 **Point** 1

Boring Profile: B-13

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Initial Effective Vertical Stress at Bottom of Soil Layer (psf)	Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)
1	Sand w/silt & clay	90	85	5	5	99.8	0	99.8	249	0.249	499	249
2	Silt w/sand, some gravel	85	81	4	29	138.1	0	138.1	775	0.775	1,052	775
3	Clay w/silt lenses	81	79	2	21	128.2	0	128.2	1,180	1.180	1,308	1,180
4	Sand w/clay lenses	79	75	4	53	145.0	0	145.0	1,598	1.598	1,888	1,598
5	Clay w/sand & silt	75	71	4	28	136.5	0	136.5	2,161	2.161	2,434	2,161
6	Clay w/sand & silt	71	70	1	28	136.5	62.4	74.1	2,471	2.471	2,508	2,471
7	Sand w/thin clay layers	70	35	35	81	145.0	62.4	82.6	3,954	3.954	5,399	3,954
8	Clay w/little silt & trace sand	35	-912	947	97	145.0	62.4	82.6	44,510	44.510	83,621	44,510
			Total:	*1002*								

Intermediate Profile >>>> With Excavation, soil is now over-consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Intermediate Effective Vertical Stress at Bottom of Soil Layer (psf)
1	Sand w/silt & clay	88	85	3	29	145.0	0	145.0	218	0.218	435
2	Silt w/sand, some gravel	85	81	4	29	138.1	0	138.1	711	0.711	988
3	Clay w/silt lenses	81	79	2	21	128.2	0	128.2	1,116	1.116	1,244
4	Sand w/clay lenses	79	75	4	53	145.0	0	145.0	1,534	1.534	1,824
5	Clay w/sand & silt	75	71	4	28	136.5	0	136.5	2,097	2.097	2,370
6	Clay w/sand & silt	71	70	1	28	136.5	62.4	74.1	2,407	2.407	2,444
7	Sand w/thin clay layers	70	35	35	81	145.0	62.4	82.6	3,890	3.890	5,335
8	Clay w/little silt & trace sand	35	-912	947	97	145.0	62.4	82.6	44,446	44.446	83,557

Waste Load U1 *B1 =* 826 *B2 =* 285 *Po =* 5,897 *psf*

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
1	Sand w/silt & clay	88	85	3	1.5	3	1.561	0.007	0.499	2,945
2	Silt w/sand, some gravel	85	81	4	5	7	1.560	0.002	0.497	2,933
3	Clay w/silt lenses	81	79	2	8	9	1.555	0.001	0.496	2,923
4	Sand w/clay lenses	79	75	4	11	13	1.550	0.001	0.494	2,913
5	Clay w/sand & silt	75	71	4	15	17	1.543	0.001	0.492	2,899
6	Clay w/sand & silt	71	70	1	17.5	18	1.538	0.001	0.490	2,890
7	Sand w/thin clay layers	70	35	35	35.5	53	1.506	0.000	0.480	2,829
8	Clay w/little silt & trace sand	35	-912	947	526.5	1000	0.808	0.000	0.257	1,518

Cell 13, Point 1, pg 1/4

Waste Load U2 B1 = 0.01 B2 = 551 Po = 5,897 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
1	Sand w/silt & clay	88	85	3	1.5	3	1.561	0.007	0.499	2,945
2	Silt w/sand, some gravel	85	81	4	5	7	1.560	0.002	0.497	2,933
3	Clay w/silt lenses	81	79	2	8	9	1.555	0.001	0.496	2,923
4	Sand w/clay lenses	79	75	4	11	13	1.550	0.001	0.494	2,913
5	Clay w/sand & silt	75	71	4	15	17	1.543	0.001	0.492	2,899
6	Clay w/sand & silt	71	70	1	17.5	18	1.538	0.001	0.490	2,890
7	Sand w/thin clay layers	70	35	35	35.5	53	1.506	0.000	0.480	2,829
8	Clay w/little silt & trace sand	35	-912	947	526.5	1000	0.808	0.000	0.257	1,518

Waste Load L1 B1 = 1011 B2 = 100 Po = 739 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
1	Sand w/silt & clay	88	85	3	1.5	3	0.000	1.569	0.500	370
2	Silt w/sand, some gravel	85	81	4	5	7	0.000	1.566	0.500	370
3	Clay w/silt lenses	81	79	2	8	9	0.001	1.563	0.500	370
4	Sand w/clay lenses	79	75	4	11	13	0.001	1.560	0.500	370
5	Clay w/sand & silt	75	71	4	15	17	0.001	1.556	0.500	370
6	Clay w/sand & silt	71	70	1	17.5	18	0.002	1.553	0.500	370
7	Sand w/thin clay layers	70	35	35	35.5	53	0.003	1.536	0.500	370
8	Clay w/little silt & trace sand	35	-912	947	526.5	1000	0.038	1.091	0.480	355

Waste Load L2 B1 = 0.01 B2 = 21 Po = 739 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
1	Sand w/silt & clay	88	85	3	1.5	3	1.493	0.007	0.478	353
2	Silt w/sand, some gravel	85	81	4	5	7	1.335	0.002	0.426	315
3	Clay w/silt lenses	81	79	2	8	9	1.206	0.001	0.385	284
4	Sand w/clay lenses	79	75	4	11	13	1.088	0.001	0.347	256
5	Clay w/sand & silt	75	71	4	15	17	0.950	0.001	0.303	224
6	Clay w/sand & silt	71	70	1	17.5	18	0.876	0.001	0.279	206
7	Sand w/thin clay layers	70	35	35	35.5	53	0.534	0.000	0.170	126
8	Clay w/little silt & trace sand	35	-912	947	526.5	1000	0.040	0.000	0.013	9

Cell 13, Point 1, pg 3/4

Load Totals

Soil Layer	*Soil Description*	*Waste Load U1 (psf)*	*Waste Load U2 (psf)*	*Waste Load L1 (psf)*	*Waste Load L2 (psf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)*
1	Sand w/silt & clay	2,945	(2,945)	370	(353)	17
2	Silt w/sand, some gravel	2,933	(2,933)	370	(315)	55
3	Clay w/silt lenses	2,923	(2,923)	370	(284)	85
4	Sand w/clay lenses	2,913	(2,913)	370	(256)	113
5	Clay w/sand & silt	2,899	(2,899)	370	(224)	146
6	Clay w/sand & silt	2,890	(2,890)	370	(206)	163
7	Sand w/thin clay layers	2,829	(2,829)	370	(126)	244
8	Clay w/little silt & trace sand	1,518	(1,518)	355	(9)	346

Final Profile

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness (ft)*	*Average SPR (N_a)*	*Estimated Unit Weight (pcf)*	*Unit Weight Water (pcf)*	*Effective Unit Weight (pcf)*	*Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)*	*Final Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)*
1	Sand w/silt & clay	88	85	3	29	145.0	0	145.0	218	17	0.017	234
2	Silt w/sand, some gravel	85	81	4	29	138.1	0	138.1	711	55	0.055	766
3	Clay w/silt lenses	81	79	2	21	128.2	0	128.2	1,116	85	0.085	1,201
4	Sand w/clay lenses	79	75	4	53	145.0	0	145.0	1,534	113	0.113	1,647
5	Clay w/sand & silt	75	71	4	28	136.5	0	136.5	2,097	146	0.146	2,243
6	Clay w/sand & silt	71	70	1	28	136.5	62.4	74.1	2,407	163	0.163	2,570
7	Sand w/thin clay layers	70	35	35	81	145.0	62.4	82.6	3,890	244	0.244	4,134
8	Clay w/little silt & trace sand	35	-912	947	97	145.0	62.4	82.6	44,446	346	0.346	44,792

Elastic Settlement

Soil Layer	*Soil Description*	*Thickness (ft)*	*Average SPR (N_a)*	*Estimated Unconfined Compression Strength qu (ksf)*	*Modulus of Elasticity Es (ksf)*	*Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)*	*Calculated Elastic Settlement (ft)*	*Calculated Elastic Settlement (in)*
1	Sand w/silt & clay	3	29		464	0.017	0.000	0.00
2	Silt w/sand, some gravel	4	29	12.0	2,246	0.055	0.000	0.00
3	Clay w/silt lenses	2	21	7.0	1,313	0.085	0.000	0.00
4	Sand w/clay lenses	4	53		848	0.113	0.001	0.01
5	Clay w/sand & silt	4	28	11.3	2,115	0.146	0.000	0.00
6	Clay w/sand & silt	1	28	11.3	2,115	0.163	0.000	0.00
7	Sand w/thin clay layers	35	81		1,296	0.244	0.007	0.08
8	Clay w/little silt & trace sand	947	97	109.0	20,443	0.346	0.016	0.19

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Recompression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Unit Weight (pcf)	Initial Void ratio e_o	Recompression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
1	Sand w/silt & clay	3	2.65	145.0	0.246	-0.043						
2	Silt w/sand, some gravel	4	2.80	138.1	0.483	0.055	0.037	775	711	766	0.006	0.07
3	Clay w/silt lenses	2	2.80	128.2	0.706	0.147	0.086	1,180	1,116	1,201	0.004	0.05
4	Sand w/clay lenses	4	2.65	145.0	0.246	-0.043						
5	Clay w/sand & silt	4	2.80	136.5	0.516	0.068	0.045	2,161	2,097	2,243	0.002	0.03
6	Clay w/sand & silt	1	2.80	136.5	0.516	0.068	0.045	2,471	2,407	2,570	0.001	0.01
7	Sand w/thin clay layers	35	2.65	145.0	0.246	-0.043						
8	Clay w/little silt & trace sand	947	2.80	145.0	0.360	0.004	0.003	44,510	44,446	44,792	0.002	0.02

Compression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Unit Weight (pcf)	Initial Void ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
1	Sand w/silt & clay	3	2.65	145.0	0.246	-0.091						
2	Silt w/sand, some gravel	4	2.80	138.1	0.483	0.116	0.078	775	711	766		
3	Clay w/silt lenses	2	2.80	128.2	0.706	0.312	0.183	1,180	1,116	1,201	0.003	0.03
4	Sand w/clay lenses	4	2.65	145.0	0.246	-0.091						
5	Clay w/sand & silt	4	2.80	136.5	0.516	0.145	0.096	2,161	2,097	2,243	0.006	0.07
6	Clay w/sand & silt	1	2.80	136.5	0.516	0.145	0.096	2,471	2,407	2,570	0.002	0.02
7	Sand w/thin clay layers	35	2.65	145.0	0.246	-0.091						
8	Clay w/little silt & trace sand	947	2.80	145.0	0.360	0.009	0.006	44,510	44,446	44,792	0.016	0.20

Summary

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Total Calculated Settlement (in)
1	Sand w/silt & clay	88	85	3	0.00	0.00	0.00	**0.00**
2	Silt w/sand, some gravel	85	81	4	0.00	0.07	0.00	**0.07**
3	Clay w/silt lenses	81	79	2	0.00	0.05	0.03	**0.09**
4	Sand w/clay lenses	79	75	4	0.01	0.00	0.00	**0.01**
5	Clay w/sand & silt	75	71	4	0.00	0.03	0.07	**0.11**
6	Clay w/sand & silt	71	70	1	0.00	0.01	0.02	**0.03**
7	Sand w/thin clay layers	70	35	35	0.08	0.00	0.00	**0.08**
8	Clay w/little silt & trace sand	35	-912	947	0.19	0.02	0.20	**0.41**
				Totals	*0.29*	*0.17*	*0.32*	
							Total	*0.78*

Cell 13, Point 1, pg 4/4

GENERAL SOIL PROFILE: CELL 13 **, POINT** 2

(NOT TO SCALE)

General Existing Profile (elev)

Boring Profile: B-13

91

Sand w/ silt & clay Navg = 5

86

Silt w/ sand, some gravel Navg = 29

82

Clay w/ silt lenses Navg = 21

80

Sand w/ clay lenses Navg = 53

76

Clay w/ sand & silt Navg = 28

71

Sand w/ thin clay layers Navg = 81

36

Clay w/ little silt & trace sand Navg = 97

21

General Final Profile (elev)

98 Top of Landfill

3' Cap & Cover

9' CDD Waste

6' Liner & Leachate Collection System

80 Floor of Landfill

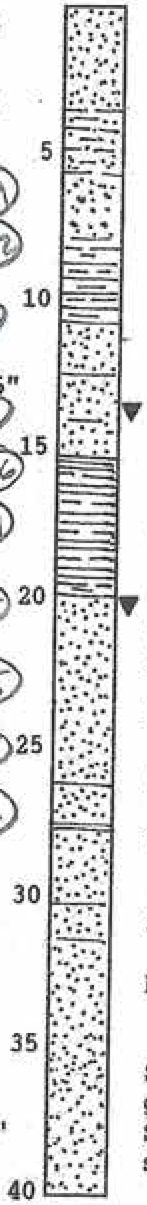
▽ 71

BORING NUMBER: B-13

TOP OF GROUND ≃ 83.0

MONITOR WELLS: MW-3

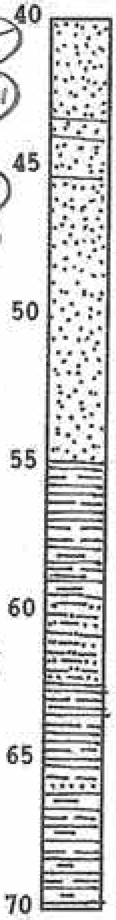
DATE INSTALLED: 7-18-89
PROJECT: CHESAPEAKE RUBBLE FILL
SAMPLE METHOD: SPLIT SPOON DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: GREG ADAMSON DRILLER: HARDIN-HUBER, INC



Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches) Ⓝ	Description
1	0 - 2	2-2-2-2 ④ (18)	SAND, med, some v fn, tr silt and clay, yellow
2	2.5-4.5	2-2-3-4 ⑤ (24)	SILT and fn SAND, tr clay, brown
3	5 - 7 5'	2-12-17-22 ㉙ (15)	2" SILT and fn SAND, as above 9" GRAVEL, little coarse sand, yellow
4	7.5-9.5 9'	15-11-11-15 ㉒ (19)	CLAY, little silt, with lenses of SILT, gray
5	10-12 11'	8-8-12-14 ⑳ (12)	6" CLAY, as above 6" SAND, med, some fn, yellow
6	12.5-14.5	17-34-51-51/5" (85) (16)	SAND, as above with thin CLAY lenses, gray, saturated
7	15-17 15'	12-12-14-22 ㉖ (24)	CLAY, little fn sand and silt, gray
8	17.5-19.5	7-12-17-17 ㉙ (19)	CLAY, little vf sand and silt, gray
9	20-22 20'	30-51/7" (100+) (9)	SAND, med, little fn, tr silt and clay, gray-yellow, saturated
10	22.5-24.5	32-34-51/5" (85) (18)	SAND, as above
11	25-27	22-34-51/5" (85) (18)	SAND, as above, clay stringers in lower 11"
12	27.5-29.5	17-35-51/5" (86) (18)	SAND, as above, with 3" CLAY layer
13	30-32	9-13-51/5" (84) (18)	SAND, as above, some thin lenses of clay, gray
14	32.5-37.5	40-51/3" (100) (0)	No recovery
15	35-37	13-25-51/5" (76) (18)	SAND, vf to med, tr silt and clay, yellow-gray, saturated and CLAY layers 2 and 4" thick
16	37.5-39.5	17-28-40-51/5" (64)	SAND, med, some fine, tr silt, lt tan, (24) saturated, with a 2" CLAY layer

BORING NUMBER: B-13 continued

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	N	Description
17	40-42	17-24-51/5" (18)	75	SAND, med and fn, little vf, tr silt and clay, few thin clay lenses, lt tan-gray
18	42.5-44.5	10-30-51/5" (18)	81	SAND, med and fn, little vf, tr silt, few thin clay lenses, tan, saturated
19	45-47	12-30-51/6" (18)	81	SAND, as above
20	47.5-49.5	45-51/2" (12)	100	SAND, as above, no clay lenses
21	50-52	45-51/6" (12)	100	SAND, as above
22	52.5-54.5	51/4" (4)	100	SAND, as above
	55			
23	55-57	25-51/5" (10)	100	CLAY, little silt, tr sand, mottled red-gray
24	57.5-59.5	51/5" (6)	100	SILT and CLAY, some sand, gray
25	60-62	28-46-51/2" (14)	97	SILT and vf SAND, little clay, gray
26	62.5-64.5	18-31-51/5" (17)	82	CLAY, some silt, tr sand, gray
27	65-67	31-51/5" (11)	100	7" CLAY, as above 2" SAND, vf, little silt, gray 2" CLAY and SILT, tr sand, brown-gray
28	67.5-69.5	45-51/5" (12)	100	CLAY and SILT, some sand, gray



Groundwater encountered at 14 feet.

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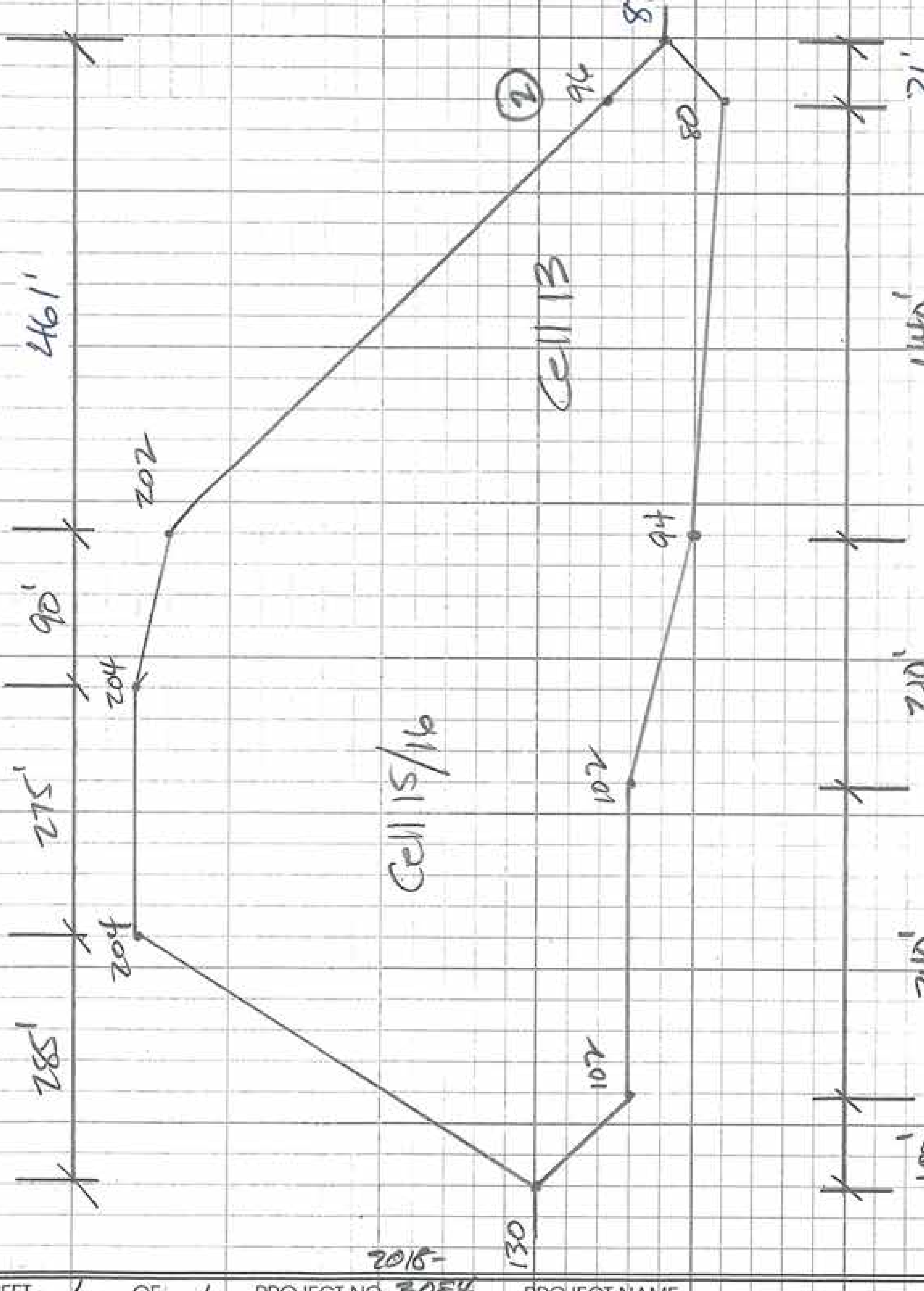
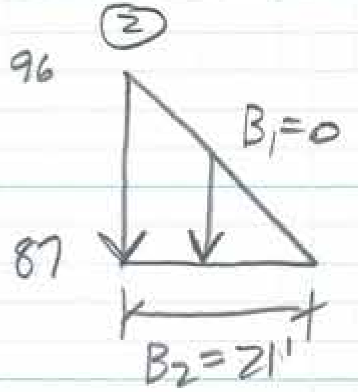


SHEET 1 OF 1 PROJECT NO. 2018-3084 PROJECT NAME

BY JCA DATE 7/11/20 DESCRIPTION Cell 13, Point 2 Settlement

CHK. BY DATE

Waste load U_1



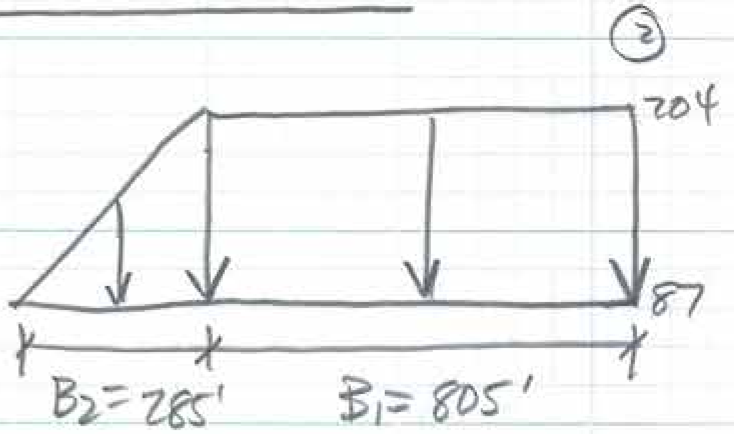
$H_{CDD} = 96-87-3 = 6'$

$p = \Sigma_1'(\gamma H)$

$= (3)(115) + (6)(48.7)$

$= 637$ psf

Waste Load U_2



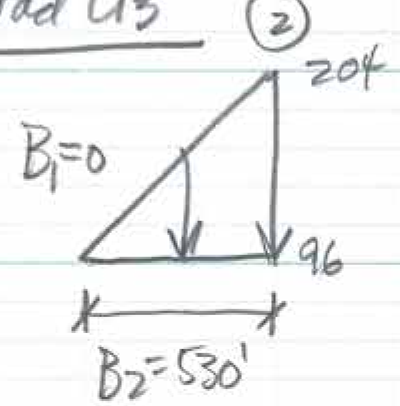
$H_{CDD} = 204-87-3 = 114'$

$p = \Sigma_1'(\gamma H)$

$= (3)(115) + (114)(48.7)$

$= 5897$ psf

Waste load U_3



$H_{CDD} = 204-96-3 = 105'$

$p = \Sigma_1'(\gamma H)$

$= (3)(115) + (105)(48.7)$

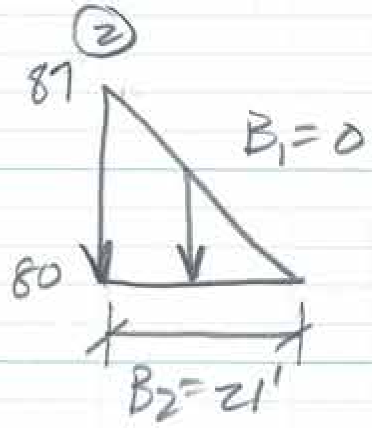
$= 5458$ psf

SHEET 1 OF 2 PROJECT NO. 2018-3054 PROJECT NAME

BY JGA DATE 7/11/20 DESCRIPTION Cell 13, Point 2 Settlement

CHK. BY DATE

Waste load L_1



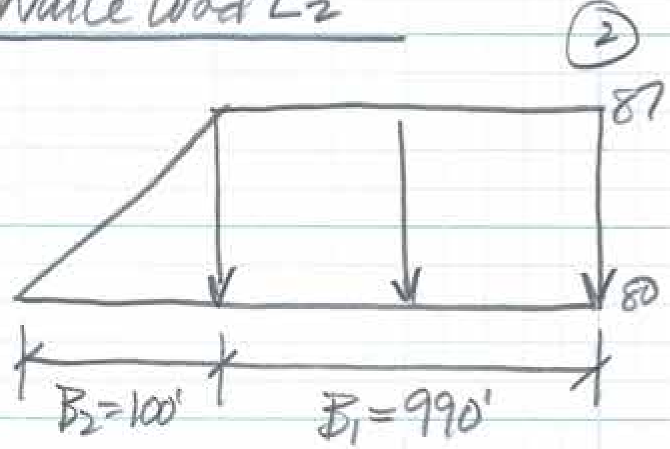
$H_{COD} = 87 - 80 - 6 = 1'$

$p = \Sigma_1(\gamma H)$

$= (1)(48.7) + (6)(115)$

$= 739$ psf

Waste load L_2



$H_{COD} = 87 - 80 - 6 = 1'$

$p = \Sigma_1(\gamma H)$

$= (1)(48.7) + (6)(115)$

$= 739$ psf

Net load $= U_1 + U_2 - U_3 + L_1 + L_2$

SHEET 2 OF 2 PROJECT NO. 2018-3084 PROJECT NAME
BY JCA DATE 7/11/20 DESCRIPTION Cell 13, Point 2 Settlement
CHK. BY DATE

Cell 13 **Point** 2

Boring Profile: B-13

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Initial Effective Vertical Stress at Bottom of Soil Layer (psf)	Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)
1	Sand w/silt & clay	91	86	5	5	99.8	0	99.8	249	0.249	499	249
2	Silt w/sand, some gravel	86	82	4	29	138.1	0	138.1	775	0.775	1,052	775
3	Clay w/silt lenses	82	80	2	21	128.2	0	128.2	1,180	1.180	1,308	1,180
4	Sand w/clay lenses	80	76	4	53	145.0	0	145.0	1,598	1.598	1,888	1,598
5	Clay w/sand & silt	76	71	5	28	136.5	0	136.5	2,229	2.229	2,571	2,229
7	Sand w/thin clay layers	71	36	35	81	145.0	62.4	82.6	4,016	4.016	5,462	4,016
8	Clay w/little silt & trace sand	36	-920	956	97	145.0	62.4	82.6	44,944	44.944	84,427	44,944
			Total Depth =	*1011*								

Interimediate Profile >>>> With excavation, soil is now over-consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Intermediate Effective Vertical Stress at Bottom of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	53	145.0	0	145.0	290	0.290	580
5	Clay w/sand & silt	76	71	5	28	136.5	0	136.5	921	0.921	1,263
7	Sand w/thin clay layers	71	36	35	81	145.0	62.4	82.6	2,708	2.708	4,154
8	Clay w/little silt & trace sand	36	-920	956	97	145.0	62.4	82.6	43,636	43.636	83,119

Waste Load U1

B1 = 0.01

B2 = 21

Po = 637

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	2	4	1.471	0.005	0.470	300
5	Clay w/sand & silt	76	71	5	6.5	9	1.269	0.002	0.405	258
7	Sand w/thin clay layers	71	36	35	26.5	44	0.670	0.000	0.214	136
8	Clay w/little silt & trace sand	36	-920	956	522	1000	0.040	0.000	0.013	8

Cell 13, Point 2 ,pg 1/4

Waste Load U2

B1 = 805

B2 = 285

Po = 5,897 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	2	4	0.001	1.568	0.500	2950
5	Clay w/sand & silt	76	71	5	6.5	9	0.002	1.563	0.500	2950
7	Sand w/thin clay layers	71	36	35	26.5	44	0.009	1.538	0.500	2950
8	Clay w/little silt & trace sand	36	-920	956	522	1000	0.129	0.996	0.474	2794

Waste Load U3

B1 = 0.01

B2 = 530

Po = 5,458 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y 0	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	2	4	1.562	0.005	0.499	2724
5	Clay w/sand & silt	76	71	5	6.5	9	1.557	0.002	0.496	2709
7	Sand w/thin clay layers	71	36	35	26.5	44	1.520	0.000	0.484	2644
8	Clay w/little silt & trace sand	36	-920	956	522	1000	0.793	0.000	0.253	1378

Waste Load L1

B1 = 0.01

B2 = 21

Po = 739 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	2	4	1.471	0.005	0.470	348
5	Clay w/sand & silt	76	71	5	6.5	9	1.269	0.002	0.405	299
7	Sand w/thin clay layers	71	36	35	26.5	44	0.670	0.000	0.214	158
8	Clay w/little silt & trace sand	36	-920	956	522	1000	0.040	0.000	0.013	9

Cell 13, Point 2, pg 2/4

Waste Load L2

B1 = 990

B2 = 100

Po = 739 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	2	4	0.000	1.569	0.500	370
5	Clay w/sand & silt	76	71	5	6.5	9	0.001	1.564	0.500	370
7	Sand w/thin clay layers	71	36	35	26.5	44	0.002	1.544	0.500	370
8	Clay w/little silt & trace sand	36	-920	956	522	1000	0.039	1.086	0.480	355

Load Totals

Soil Layer	Soil Description	Load U1 (psf)	Load U2 (psf)	Load U3 (psf)	Load L1 (psf)	Load L2 (psf)	Increase in Effective Pressure (p') at Center of Soil Layer (psf)
4	Sand w/clay lenses	300	2,950	(2,724)	348	370	1,243
5	Clay w/sand & silt	258	2,950	(2,709)	299	370	1,168
7	Sand w/thin clay layers	136	2,950	(2,644)	158	370	970
8	Clay w/little silt & trace sand	8	2,794	(1,378)	9	355	1,787

Final Profile

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v$') at Center of Soil Layer (ksf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)
4	Sand w/clay lenses	80	76	4	145.0	0	145.0	290	1,243	1.243	1,533
5	Clay w/sand & silt	76	71	5	136.5	0	136.5	921	1,168	1.168	2,089
7	Sand w/thin clay layers	71	36	35	145.0	62.4	82.6	2,708	970	0.970	3,678
8	Clay w/little silt & trace sand	36	-39	75	145.0	62.4	82.6	43,636	1,787	1.787	45,424

Cell 13, Point 2, pg 3/4

Elastic Settlement

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_a)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
4	Sand w/clay lenses	4	53		848	1.243	0.006	0.07
5	Clay w/sand & silt	5	28	11.3	4,936	1.168	0.001	0.01
7	Sand w/thin clay layers	35	81		1,296	0.970	0.026	0.31
8	Clay w/little silt & trace sand	75	97	109.0	47,699	1.787	0.003	0.03

Recompression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void Ratio e_o	Compression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
4	Sand w/clay lenses	4	2.65	145.0								
5	Clay w/sand & silt	5	2.80	136.5	0.516	0.068	0.045	2,229	921	2,089	0.069	0.83
7	Sand w/thin clay layers	35	2.65	145.0								
8	Clay w/little silt & trace sand	75	2.80	145.0	0.360	0.004	0.003	44,944	43,636	45,424	0.001	0.02

Compression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void Ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
4	Sand w/clay lenses	4	2.65	145.0								
5	Clay w/sand & silt	5	2.80	136.5	0.516	0.145	0.096	2,229	921	2,089	-0.01	-0.16
7	Sand w/thin clay layers	35	2.65	145.0								
8	Clay w/little silt & trace sand	75	2.80	145.0	0.360	0.009	0.006	44,944	43,636	45,424	0.00	0.03

Summary

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Total Calculated Settlement (in)
4	Sand w/clay lenses	80	76	4	0.1			0.07
5	Clay w/sand & silt	76	71	5	0.0	0.83	-0.16	0.68
7	Sand w/thin clay layers	71	36	35	0.3			0.31
8	Clay w/little silt & trace sand	36	-39	75	0.0	0.02	0.03	0.08
							Total	1.14

Cell 13, Point 2, pg 4/4

GENERAL SOIL PROFILE: CELL 13**, POINT** 3

(NOT TO SCALE)

General Existing Profile (elev)

Boring Profile: B-12

95

Clay, silt & clay w/sand Navg=11

90

Sand w/some silt & clay Navg=39

85

Sand w/silt & clay Navg=18

73

Sand w/silt & few thin clay layers Navg=

52

Clay w/some sand Navg=

23

Clay & silt w/sand Navg=

15

General Final Profile (elev)

202 Top of landfill

3' Cap & Cover

99' CDD waste

6' Liner & Leachate Collection System

94 Floor of landfill

▽ 72

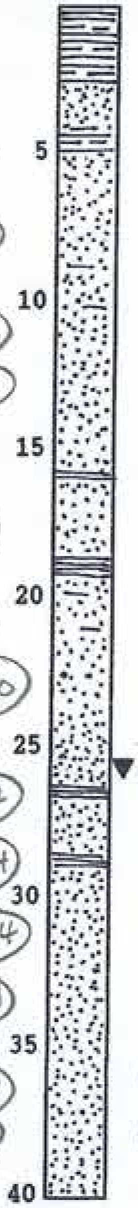
TOP OF GROUND ≃ 97.0

BORING NUMBER: B-12

MONITOR WELLS: MW-4

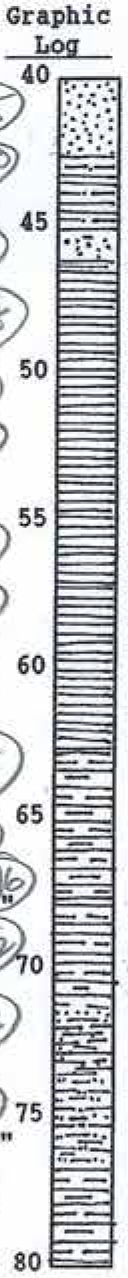
DATE INSTALLED: 7-22-89
PROJECT: CHESAPEAKE RUBBLE FILL
SAMPLE METHOD: SPLIT SPOON DRILLING METHOD: HOLLOW STEM AUGER and MUD
LOGGED BY: GREG ADAMSON DRILLER: HARDIN-HUBER, INC

Ⓝ

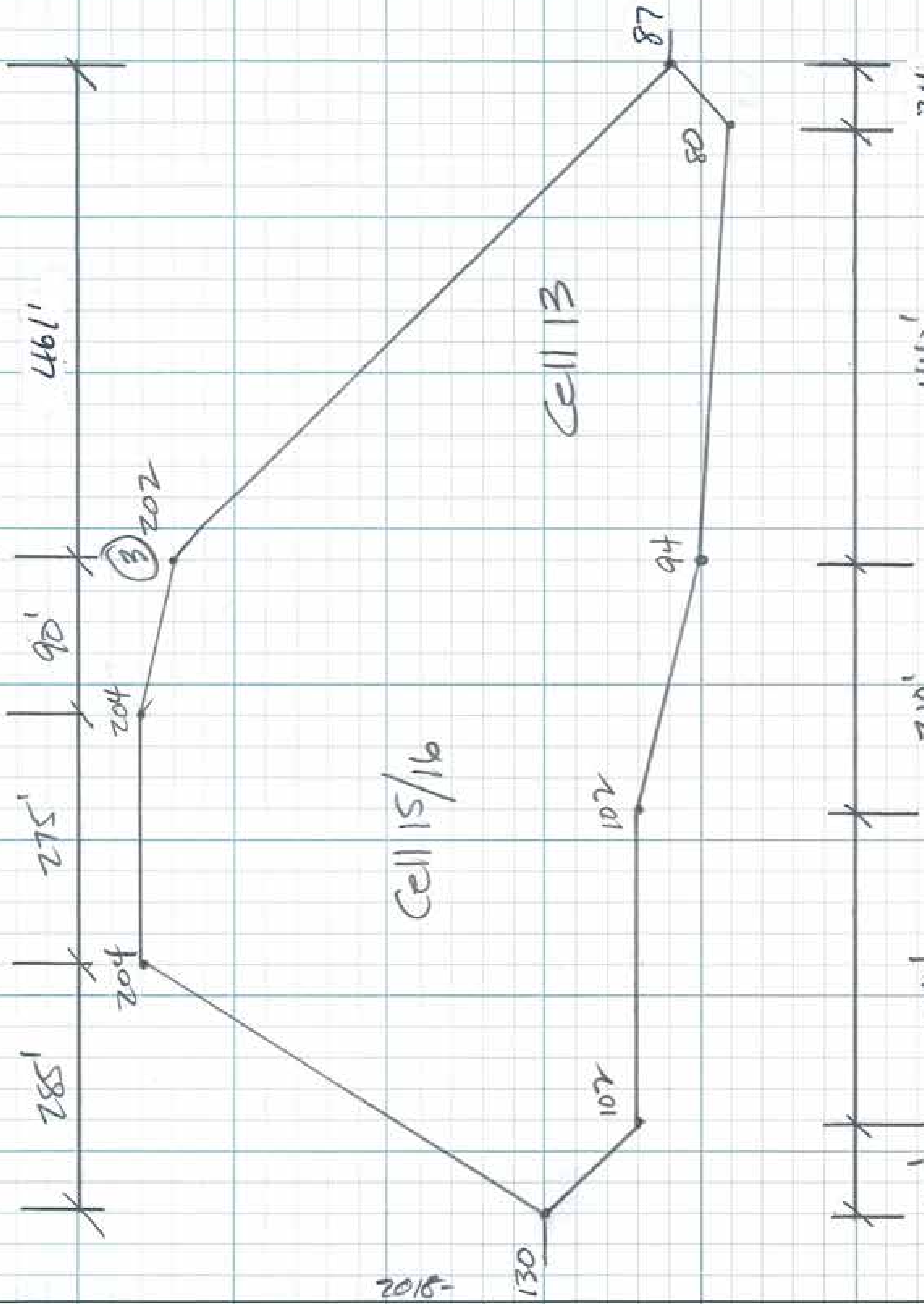
Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	Graphic Log	Description
1	0 - 2	3-3-4-6 ⑦ (16)		CLAY, little silt and sand, red-br-yellow
2	2.5-4.5	3-7-9-11 ⑯ (21)		16" SAND, fn & vf, tr silt & clay, rd-br-yellow 5" SILT and CLAY, little sand, yellow-red
3	5' 5 - 7	㊳ 9-19-19-30 (17)		SAND, med, some fn, tr silt and clay, red-brown-lt tan
4	7.5-9.5	6-18-21-26 ㊵ (20)		8" SAND, as above 12" SAND, fn to vf, some silt, tr clay, lt tan-red-brown
5	10-12 10'	7-13-13-16 ㉖ (19)		SAND, med, some fn, tr silt, lt tan-red-brown
6	12.5-14.5	6-10-11-13 ㉑ (21)		SAND, fn and vf, little med, tr silt and clay, lt tan-red-brown
7	15-17	3-3-5-3 ⑧ (20)		SAND, as above, gray and red-brown, with 2" clay layer
8	17.5-19.5	3-5-11-24 ⑯ (18)		5" SAND, as above 13" CLAY, some silt, tr sand, gray
9	20-22 22'	3-5-16-24 ㉑ (17)		SAND, med, some fn, some silt and clay stringers, gray-red-brown-yellow
10	22.5-24.5	30-33-27-18 (60) (17)		8" GRAVEL, some sand, tr silt, red-brown 9" SAND, fn to vf, tr silt & clay, red-br-gray
11	25-27	5-20-41-51/5" (92) (24)	▼	▽ 6" SAND, as above 6" CLAY, ltl silt, thin sand lenses, gray 8" SAND, med-fn, gray-rd-br, saturated
12	27.5-29.5	20-24-30-38 (54) (20)		10" CLAY, ltl sand and silt, gray-rd-br 10" SAND, med, ltl fn, tr silt & clay, gray
13	30-32	22-28-36-40 (64) (20)		SAND, as above, saturated
14	32.5-34.5	27-38-43-51 (81) (24)		SAND, as above
15	35-37	33-51/6" (100) (12)		SAND, as above
16	37.5-39.5	15-51/6" (100) (12)		SAND, as above

BORING NUMBER: B-12 continued

Sample No.	Depth (ft)	Blows per 6 inches (recovery in inches)	Description
17	40-42	4-14-51/5" 65 (8)	SAND, as above
18	43' 42.5-44.5	45-51/3" 100 (8)	CLAY, little silt and sand, with thin sand lenses, mottled red-gray
19	45-47	14-45-48 93 (18)	11" SAND, med and coarse, tr silt & clay, gray 7" CLAY, tr silt and sand, dense, gray
20	47.5-49.5	35-47-51/4" 98 (16)	CLAY, as above
21	50-52	33-51/4" 100 (0)	No recovery - drilled like clay
22	52.5-54.5	29-51/6" 100 (12)	CLAY, as above, mottled gray-red-br-purple
23	55-57	43-51/5" 100 (11)	CLAY, as above
24	57.5-59.5	34-51/5" 100 (0)	No recovery, drilled like clay
25	60-62	36-51/5" 100 (11)	CLAY, as above
26	62.5-64.5	41-33-42-47 75 (21)	6" CLAY, as above 15" CLAY and SILT, little sand, gray
27	65-67	45-51/5" 100 (0)	No recovery
28	67.5-69.5	37-45-47-51/5" 96 (15)	CLAY, some silt, tr sand, red-br-gray
29	70-72 72'	19-29-33-42 62 (21)	10" CLAY, as above 5" CLAY & SILT, tr sand, mottled red-br-gray 6" SAND, vf, some silt, tr clay, gray
30	72.5-74.5	10-27-36-49 63 (0)	No recovery
31	75-77	19-29-38-51/5" 67 (21)	7" SILT & vf SAND, tr clay, mott rd-br-gray 14" SILT & CLAY, little vf sand, red-br-gray
32	77.5-79.5	21-28-51/5" 79 (17)	SILT and CLAY, as above



Groundwater on the drill rods at 34 feet.

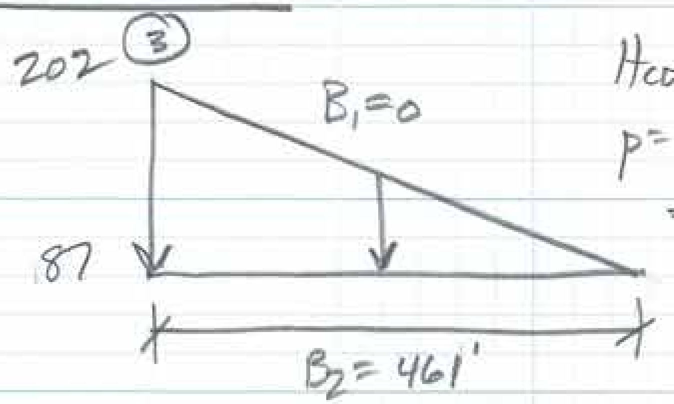


SHEET 1 OF 1 PROJECT NO. 2018-3084 PROJECT NAME

BY JCA DATE 7/11/20 DESCRIPTION Cell 13, Point 3 Settlement

CHK. BY DATE

Waste Load U_1



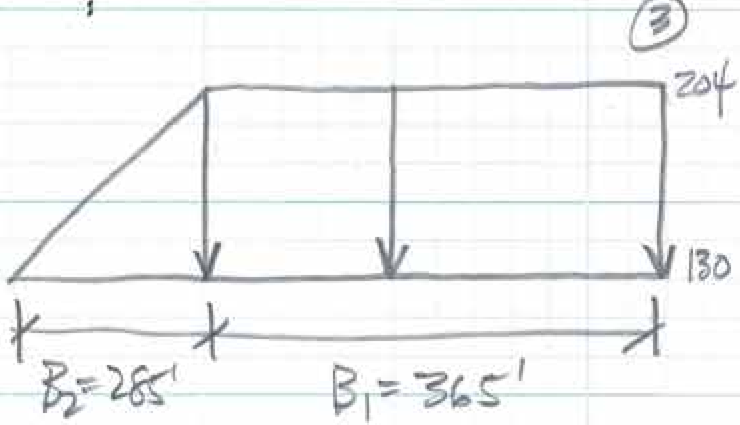
$H_{CDD} = 202-87-3 = 112$

$p = \Sigma(\gamma H)$

$= (3)(115)+(112)(48.7)$

$= 5799$ psf

Waste Load U_2



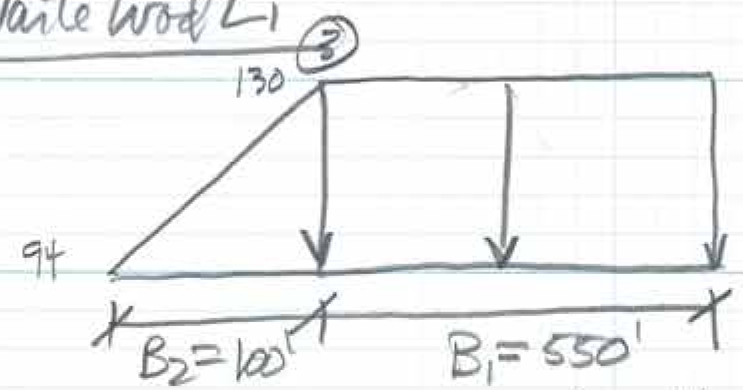
$H_{CDD} = 204-130-3 = 71'$

$p = \Sigma(\gamma H)$

$= (3)(115)+(71)(48.7)$

$= 3803$ psf

Waste Load L_1



$H_{CDD} = 130-94-6 = 30'$

$p = \Sigma(\gamma H)$

$= (30)(48.7)+(6)(115)$

$= 2151$ psf

Net load $= U_1 + U_2 + L_1$

SHEET 1 OF 1 PROJECT NO 2018-3084 PROJECT NAME

BY JKA DATE 7/11/20 DESCRIPTION Cell 13, Point 3 Settlement

CHK. BY DATE

Cell 13 **Point** 3

Boring Profile: B-12

Existing Profile >>>> Assume soil is normally consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Soil Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Soil Unit Weight (kcf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Initial Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Initial Effective Vertical Stress at Bottom of Soil Layer (psf)	Estimated Effective Pre-consolidation Stress (σ_p') at Center of Soil Layer (psf)
1	Sand w/trace fines	136	112	24	11	117.7	0	117.7	1,413	1.413	2,826	1,413
2	Sand w/trace fines	112	110	2	11	117.7	62.4	55.3	2,881	2.881	2,936	2,881
3	Sand w/trace fines	110	100	10	34	131.5	62.4	69.1	3,282	3.282	3,627	3,282
4	Clay to Clayey Silt	100	35	65	49	145.0	62.4	82.6	6,312	6.312	8,996	6,312
5	Silty Clayey Sand to Silty Sand	35	5	30	74	145.0	62.4	82.6	10,235	10.235	11,474	10,235
6	Clay	5	-874	879	70	145.0	62.4	82.6	47,777	47.777	84,079	47,777
			Total Depth =	*1010*								

Interimediate Profile >>>> With excavation, soil is now over-consolidated.

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_a)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (ksf)	Intermediate Effective Vertical Stress at Bottom of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	11	117.7	0	117.7	824	0.824	1,648
2	Sand w/trace fines	112	110	2	11	117.7	62.4	55.3	1,704	1.704	1,759
3	Sand w/trace fines	110	100	10	34	131.5	62.4	69.1	2,104	2.104	2,450
4	Clay to Clayey Silt	100	35	65	49	145.0	62.4	82.6	5,134	5.134	7,819
5	Silty Clayey Sand to Silty Sand	35	5	30	74	145.0	62.4	82.6	9,058	9.058	10,297
6	Clay	5	-874	879	70	145.0	62.4	82.6	46,599	46.599	82,902

Waste Load U1 B1 = 0.01 B2 = 461 Po = 5,799 psf

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness ft	z ft	y ft	α_1 (radians)	α_2 (radians)	Influence Factor I'	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	7	14	1.554	0.001	0.495	2873
2	Sand w/trace fines	112	110	2	15	16	1.538	0.001	0.490	2841
3	Sand w/trace fines	110	100	10	21	26	1.525	0.000	0.486	2817
4	Clay to Clayey Silt	100	35	65	58.5	91	1.444	0.000	0.460	2668
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	1.345	0.000	0.428	2484
6	Clay	5	-874	879	560.5	1000	0.688	0.000	0.219	1271

Cell 13, Point 3, pg 1/4

Waste Load U2

B1 = 365 *B2 =* 285 *Po =* 3,803 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	α_1 *(radians)*	α_2 *(radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress (* $\Delta\sigma_v'$ *) at Center of Soil Layer (psf)*
1	Sand w/trace fines	126	112	14	7	14	0.008	1.552	0.500	1902
2	Sand w/trace fines	112	110	2	15	16	0.018	1.530	0.500	1902
3	Sand w/trace fines	110	100	10	21	26	0.025	1.513	0.500	1902
4	Clay to Clayey Silt	100	35	65	58.5	91	0.069	1.412	0.500	1901
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.121	1.288	0.498	1894
6	Clay	5	-874	879	560.5	1000	0.282	0.577	0.389	1478

Waste Load L1

B1 = 550 *B2 =* 100 *Po =* 2,151 *psf*

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*z ft*	*y ft*	α_1 *(radians)*	α_2 *(radians)*	*Influence Factor I'*	*Increase in Effective Vertical Stress (* $\Delta\sigma_v'$ *) at Center of Soil Layer (psf)*
1	Sand w/trace fines	126	112	14	7	14	0.002	1.558	0.500	1076
2	Sand w/trace fines	112	110	2	15	16	0.004	1.544	0.500	1076
3	Sand w/trace fines	110	100	10	21	26	0.006	1.533	0.500	1076
4	Clay to Clayey Silt	100	35	65	58.5	91	0.016	1.465	0.500	1076
5	Silty Clayey Sand to Silty Sand	35	5	30	106	121	0.029	1.380	0.499	1074
6	Clay	5	-874	879	560.5	1000	0.083	0.776	0.419	902

Load Totals

Soil Layer	*Soil Description*	*Top Elev (ft)*	*Bottom Elev (ft)*	*Thickness ft*	*Waste Load U1 (psf)*	*Waste Load U2 (psf)*	*Waste Load L1 (psf)*	*Total Increase in Effective Vertical Stress (* $\Delta\sigma_v'$ *) at Center of Soil Layer (psf)*
1	Sand w/trace fines	126	112	14	2,873	1,902	1,076	5,851
2	Sand w/trace fines	112	110	2	2,841	1,902	1,076	5,819
3	Sand w/trace fines	110	100	10	2,817	1,902	1,076	5,795
4	Clay to Clayey Silt	100	35	65	2,668	1,901	1,076	5,645
5	Silty Clayey Sand to Silty Sand	35	5	30	2,484	1,894	1,074	5,452
6	Clay	5	-874	879	1,271	1,478	902	3,651

Cell 13, Point 3, pg 3/4

Final Profile

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Average SPR (N_o)	Estimated Unit Weight (pcf)	Unit Weight Water (pcf)	Effective Unit Weight (pcf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (psf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Final Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)
1	Sand w/trace fines	126	112	14	11	117.7	0.0	117.7	824	5,851	5.851	6,676
2	Sand w/trace fines	112	110	2	11	117.7	62.4	55.3	1,704	5,819	5.819	7,523
3	Sand w/trace fines	110	100	10	34	131.5	62.4	69.1	2,104	5,795	5.795	7,900
4	Clay to Clayey Silt	100	35	65	49	145.0	62.4	82.6	5,134	5,645	5.645	10,779
5	Silty Clayey Sand to Silty Sand	35	5	30	74	145.0	62.4	82.6	9,058	5,452	5.452	14,509
6	Clay	5	-874	879	70	145.0	62.4	82.6	46,599	3,651	3.651	50,251

Elastic Settlement

Soil Layer	Soil Description	Thickness (ft)	Average SPR (N_o)	Estimated Unconfined Compression Strength qu (ksf)	Modulus of Elasticity Es (ksf)	Increase in Effective Vertical Stress ($\Delta\sigma_v'$) at Center of Soil Layer (ksf)	Calculated Elastic Settlement (ft)	Calculated Elastic Settlement (in)
1	Sand w/trace fines	14	11		176	5.851	0.47	5.59
2	Sand w/trace fines	2	11		176	5.819	0.07	0.79
3	Sand w/trace fines	10	34		544	5.795	0.11	1.28
4	Clay to Clayey Silt	65	49	30.3	13,276	5.645	0.03	0.33
5	Silty Clayey Sand to Silty Sand	30	74		1,184	5.452	0.14	1.66
6	Clay	879	70	58.8	25,707	3.651	0.12	1.50

Recompression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Recompression Index C_r	Corrected Recompression Index C_{rc}	Effective Pre-consolidation Stress (σ_p') (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Recompression Settlement (ft)	Calculated Recompression Settlement (in)
4	Clay to Clayey Silt	65	2.80	145.0	0.360	0.004	0.003	6,312	5,134	10,779	0.017	0.21
6	Clay	879	2.80	145.0	0.360	0.004	0.003	47,777	46,599	50,251	0.028	0.34

Cell 13, point 3, pg 3/4

Compression Settlement - Cohesive Soils

Soil Layer	Soil Description	Thickness (ft)	Specific Gravity	Estimated Unit Weight (pcf)	Initial Void ratio e_o	Compression Index C_c	Corrected Compression Index C_{cc}	Effective Pre-consolidation Stress (σ_p') (psf)	Intermediate Effective Vertical Stress (σ_{vo}') at Center of Soil Layer (psf)	Final Effective Vertical Stress (σ_{vf}') at Center of Soil Layer (psf)	Calculated Compression Settlement (ft)	Calculated Compression Settlement (in)
4	Clay to Clayey Silt	65	2.80	145.0	0.360	0.009	0.006	6,312	5,134	10,779	0.095	1.14
6	Clay	879	2.80	145.0	0.360	0.009	0.006	47,777	46,599	50,251	0.122	1.46

Summary

Soil Layer	Soil Description	Top Elev (ft)	Bottom Elev (ft)	Thickness (ft)	Calculated Elastic Settlement (in)	Calculated Recompression Settlement (in)	Calculated Compression Settlement (in)	Total Calculated Settlement (in)
1	Sand w/trace fines	126	112	14	5.59			5.59
2	Sand w/trace fines	112	110	2	0.79			0.79
3	Sand w/trace fines	110	100	10	1.28			1.28
4	Clay to Clayey Silt	100	35	65	0.33	0.21	1.14	1.68
5	Silty Clayey Sand to Silty Sand	35	5	30	1.66			1.66
6	Clay	5	-874	879	1.50	0.34	1.46	3.30
			Totals		11.14	0.55	2.60	14.29

Cell 13, Point 3, pg 4/4

REFERENCE 9

PRODUCT DATA SHEET

GSE HD Textured Geomembrane

GSE HD Textured is a co-extruded textured high density polyethylene (HDPE) geomembrane available on one or both sides. It is manufactured from the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased frictional resistance, excellent chemical resistance and endurance properties.

[*]

AT THE CORE:
An HDPE geomembrane used in applications that require increased frictional resistance, excellent chemical resistance and endurance properties.

Product Specifications

These product specifications meet GRI GM13

Tested Property	Test Method	Frequency	Minimum Average Value				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	30 27	40 36	60 54	80 72	100 90
Density, g/cm^3	ASTM D 1505	200,000 lb	0.940	0.940	0.940	0.940	0.940
Tensile Properties (each direction Strength at Break, lb/in-width Strength at Yield, lb/in-width Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in G.L. 1.3 in	20,000 lb	45 63 100 12	60 84 100 12	90 126 100 12	120 168 100 12	150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lb	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lb	45	60	90	120	150
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[1]	Note[1]	Note[1]	Note[1]	Note[1]
Asperity Height, mil	ASTM D 7466	second roll	16	18	18	18	18
Notched Constant Tensile Load[2], hr	ASTM D 5397, Appendix	200,000 lb	500	500	500	500	500
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>100	>100	>100	>100	>100
TYPICAL ROLL DIMENSIONS							
Roll Length[3], ft	Double-Sided Textured Single-Sided Textured		830 1,010	700 780	520 540	400 410	330 330
Roll Width[3], ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		18,675 22,725	15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:

- [1] Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2] NCTL for GSE HD Textured is conducted on representative smooth membrane samples.
- [3] Roll lengths and widths have a tolerance of ±1%.
- GSE HD Textured is available in rolls weighing approximately 4,000 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

[**DURABILITY RUNS DEEP**] For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

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ENVIRONMENTAL™

REV 10DEC2014

ATTACHMENT 9G

Closure Cap Veneer Stability

ADVANCED GeoServices a Montrose Environmental Group company	**Subject:** Cap System – Finite (Veneer) Stability Analysis		
	Job No. 2018-3854	**Made by:** JCA	**Date** 06/21/20
	Ref.	**Checked by:** VEF	**Sheet** 1 of 3

Reviewed by PGS 09/01/2021

Objective: These calcualtions were performed for a cap constructed at slope of 3 horizontal to 1 vertical (3:1). The revised design has liner component slopes of 4:1 or flatter. This means that the conclusions and recommendations derived from these calculations are still protective, and can still be followed.

The objective of this analysis is to evaluate the veneer stability of the cap system under both drained and undrained conditions, as well as with static and dynamic loading.

Design Approach and Assumptions:

1. The steepest cap slope is 3H: 1V (33%). The longest slope length between berms is 95 ft. (30.0 ft high).

2. The proposed cap system consists of the following components from top to bottom:

   0.5 ft Vegetative Soil;
   1.5 ft Cover Soil;
   Geocomposite Drainage Net;
   Textured Geomembrane; and,
   1.0 ft Intermediate Cover Soil atop Waste.

3. It was assumed that the 2-ft cover soils (vegetative and protective soil) have uniform properties: unit weight of 120 pcf, cohesion of 20 psf, and friction angle of 30 degrees. Higher friction angle values have been documented on another recent project in the Mid-Atlantic Region. However, the value chosen here was considered conservative.

4. The target factors of safety (FS) against veneer instability at the cover are 1.5 for static and construction loading, and 1.0 for seismic loading. The target FS of 1.5 was adopted based on the assumption the site is for non-hazard waste and high in importance ranking.

5. From USGS seismic map, the seismic coefficient (peak ground acceleration) at the site is approximately 0.065g.

6. Low ground pressure equipment is typically used for landfill cap construction. This analysis assumes CAT D6N LGP dozer was assumed to be used in the construction.

7. Interface friction angles were taken from GRI Report #30 (direct shear database).

8. The analyses were performed following Koerner and Soong 2005. As is common, soil cohesion and interface adhesion were neglected to be conservative.

Reviewed by PGS 09/01/2021

Calculations:

This analysis considered the following scenarios (the calculation spread sheets and equations used for the calculation are attached):

Case 1. Static, Drained;
Case 2. Dynamic, Drained, CAT D6N LGP Pushing Upslope;
Case 3. Dynamic, Drained, CAT D6N LGP Pushing Downslope;
Case 5a. Static, Undrained, Slope Parallel Seepage Build-up to 50% Cap Thickness;
Case 5b. Static, Undrained, Slope Parallel Seepage Build-up to 100% Cap Thickness; and,
Case 6. Dynamic, Drained, Seismic Loading.

The method used here includes a "Case 4" which addresses the physical situation of horizontal seepage build-up on the cap. For this project, a horizontal seepage build-up is not possible. The summary of the calculated FS values is shown the following table:

Scenario	**Target Factor of Safety, FS_{min}**	**Calculated Factor of Safety, FS_{min}**	**Acceptable? (Yes or No)**
Case 1. Static, Drained	1.5	1.54	**Yes**
Case 2. Dynamic, Drained, CAT D6N LGP Pushing Upslope	1.5	1.52	**Yes**
Case 3. Dynamic, Drained, CAT D6N LGP Pushing Downslope	1.5	1.37	**No**
Case 5a. Static, Undrained, Slope Parallel Seepage Build-up to 50% Cap Thickness	1.5	1.13	**No**
Case 5b. Static, Undrained, Slope Parallel Seepage Build-up to 100% Cap Thickness	1.5	0.81	**No**
Case 6. Dynamic, Drained, Seismic Loading	1.0	1.24	**Yes**

CONCLUSIONS:

Based on the foregoing, the following conclusions are presented:

1. Case 3 has an unacceptable FS values where construction equipment is presumed to be pushing downslope. Therefore, the operation should not allow construction equipment to push downslope.

2. Cases 5a and 5b have unacceptable FS values where seepage is permitted to build up in the cap layer.. Therefore, the design should accommodate the seepage through the cap to be completely contained within the geocomposite drainage net.

3. To successfully accomplish the construction and operation of the landfill with respect to cap stability, the materials used should meet or exceed the parameters used in this analysis.

References:

Koerner, R.M., and Soong, T.Y.; *"Analysis and Design of Veneer Cover Soils"*; Geosynthetics International, 2005, Vol. 12, No.1, p28-49.

Soong, T.Y, and Koerner, R.M.; *"Cover Soil Slope Stability Involving Geosynthetic Interfaces"*, GRI Report #18, 1996.

Koerner, R.M., and Daniel, D.; *"Final Covers for Solid Waste Landfills and Abandoned Dumps"*, 1997.

Soong, T.Y, and Koerner, R.M.; *"The Design of Drainage Systems over Geosynthetically Lined Slopes"*; , GRI Report #19, 1997.

Koerner, G.R., Narejo, D.; *"Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"*; GRI Report #30, 2005.

U.S.E.P.A.; *"RCRA Substitute D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities"*; EPA/600/R-95/051, April, 1995.

Map on Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years, USGS Map, Oct. 2002.

ADVANCED GeoServices
a Montrose Environmental Group company

Project:
P.N.: 2018-3854
By: JCA
Checked: VEJ
Subject: Cap System - Finite (Veneer) Slope Analysis

Page: 1 of 5
Date: 06/21/20
Date: 09/14/20

Description

Perform a finite slope (veneer) analysis of the cap system.

Slope Information

Slope, β = 3 H to 1V = 18.4 deg 2β = 36.87 deg
Maximum Slope Length, L = 95 ft
Height of Slope, H = 30 ft

Materials

Cover Soil = USCS Silty Sand to Clayey Sand, SM - SC
Cover soil thickness, h = 2 ft
Moist unit weight, γ_{moist} = 115 pcf
Saturated unit weight, γ_{sat} = 130 pcf
Internal friction angle, ϕ = 28 deg
Soil cohesion, c = 0 psf
Water unit weight, γ_w = 62.4 pcf
Geocomposite drainage net, GDN = GSE TenFlow 350 with NW-NP-GT both sides
Textured Geomembrane = 40-mil LLDPE-T

Interface Friction Angles

Cover soil to GDN, δ_1 = 27 deg
GDN to LLDPE-T, δ_2 = 26 deg
LLDPE to cover soil, δ_3 = 26 deg
All interface adhesion, c_a = 0 kPa = 0.0 psf

Use δ = 26 deg

Case 1: Static, Drained

$\sin\beta$ = 0.32
$\tan\beta$ = 0.33
$\cos\beta$ = 0.95
$\sin^2\beta$ = 0.10
$\sin 2\beta$ = 0.60
$\tan\phi$ = 0.53
$\tan\delta$ = 0.49

W_A = 20,442 lb/ft
W_P = 767 lb/ft
N_A = 19,393 lb/ft
C_a = 0 lb/ft
C = 0 lb/ft
a = 1,939 lb/ft
b = -3,310 lb/ft
c = 503 lb/ft

Minimum Factor of Safety, FSmin = 1.5
Factor of Safety, FS = 1.54

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Project:
P.N.: 2018-3854
Page: 2 of 5
By: JCA
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Subject: Cap System - Finite (Veneer) Slope Analysis

Case 2: Dynamic, Drained, Equipment Pushing Upslope

sin β = 0.32
tan β = 0.33
cos β = 0.95
sin $^2\beta$ = 0.10
sin 2β = 0.60
tan ϕ = 0.53
tan δ = 0.49

W_A = 20,442 *lb/ft*
W_P = 767 *lb/ft*
N_A = 19,393 *lb/ft*
C_a = 0 *lb/ft*
C = 0 *lb/ft*
a = 8,102 *lb/ft*
b = -13,699 *lb/ft*
c = 2,101 *lb/ft*

q = 685 *lb/ft*
We = 6,565 *lb/ft*
Ne = 6,228 *lb/ft*

Weight of Equipment, W_b = 39,112
Length of Equipment Track, w = 10.2
Width of Equipment Track, b = 2.8
Width-to-Thickness Ratio, b/h = 1.4
Influence Factor, I = 0.94

Minimum Factor of Safety, FSmin = 1.5
Factor of Safety, FS = 1.52

Case 3: Dynamic, Drained, Equipment Pushing Downslope

sin β = 0.32
tan β = 0.33
cos β = 0.95
sin $^2\beta$ = 0.10
sin 2β = 0.60
tan ϕ = 0.53
tan δ = 0.49

W_A = 20,442 *lb/ft*
W_P = 767 *lb/ft*
N_A = 19,393 *lb/ft*
C_a = 0 *lb/ft*
C = 0 *lb/ft*
a = 9,036 *lb/ft*
b = -13,864 *lb/ft*
c = 2,101 *lb/ft*

q = 685 *lb/ft*
We = 6,565 *lb/ft*
Ne = 6,228 *lb/ft*
Fe = 985 *lb/ft*
lb/ft

Dozer-to-Gravity Acceleration Ratio, a/g = 0.15
Acceleration of Dozer, a_d = 4.827 *ft/s* ^{2}
Anticipated speed = 15 *mi/hr*
= 24.1 *km/h*
Time to speed = 4 *s*

Minimum Factor of Safety, FSmin = 1.5
Factor of Safety, FS = 1.36

Project:
P.N.: 2018-3854
Page: 3 of 5
By: JCA
Date: 06/21/20
Checked:
Date: 07/14/20
Subject: Cap System - Finite (Veneer) Slope Analysis

Case 5a: Static, Undrained, Slope Parallel Seepage Build-up to 50% of Cap Thickness

$\sin \beta$ =	0.32	W_A =	22,451	lb/ft	Uv =	374	lb/ft
$\tan \beta$ =	0.33	W_P =	792	lb/ft	Uh =	31	lb/ft
$\cos \beta$ =	0.95	N_A =	15,791	lb/ft	Un =	5,517	lb/ft
$\sin^2 \beta$ =	0.10	C_a =	0	lb/ft			
$\sin 2\beta$ =	0.60	C =	0	lb/ft			
$\tan \phi$ =	0.53	a =	6,738	lb/ft			
$\tan \delta$ =	0.49	b =	-8,717	lb/ft			
		c =	1,295	lb/ft			

Thickness of Saturated Layer, hw = 1.0 ft

Saturated Soil Unit Weight, γ_{sat} = 130 pcf

Parallel Submergence Ratio, PSR = hw/h = 0.50

Minimum Factor of Safety, FSmin = 1.5

Factor of Safety, FS = 1.12

Case 5b: Static, Undrained, Slope Parallel Seepage Build-up to 100% of Cap Thickness

$\sin \beta$ =	0.32	W_A =	23,799	lb/ft	Uv =	374	lb/ft
$\tan \beta$ =	0.33	W_P =	867	lb/ft	Uh =	125	lb/ft
$\cos \beta$ =	0.95	N_A =	11,780	lb/ft	Un =	10,837	lb/ft
$\sin^2 \beta$ =	0.10	C_a =	0	lb/ft			
$\sin 2\beta$ =	0.60	C =	0	lb/ft			
$\tan \phi$ =	0.53	a =	7,152	lb/ft			
$\tan \delta$ =	0.49	b =	-6,958	lb/ft			
		c =	966	lb/ft			

Thickness of Saturated Layer, hw = 2.0 ft

Saturated Soil Unit Weight, γ_{sat} = 130 pcf

Parallel Submergence Ratio, PSR = hw/h = 1.00

Minimum Factor of Safety, FSmin = 1.5

Factor of Safety, FS = 0.81

Case 6: Dynamic, Drained, Seismic Loading

$\sin \beta =$	0.32	$W_A =$	20,363	lb/ft
$\tan \beta =$	0.33	$W_P =$	767	lb/ft
$\cos \beta =$	0.95	$N_A =$	19,318	lb/ft
$\sin^2 \beta =$	0.10	$C_a =$	0	lb/ft
$\sin 2\beta =$	0.60	$C =$	0	lb/ft
$\tan \phi =$	0.53	$a =$	6,447	lb/ft
$\tan \delta =$	0.49	$b =$	-9,232	lb/ft
Seismic coefficient, Cs =	0.065	$c =$	1,503	lb/ft
(0.5)Cs =	0.0325			

Minimum Factor of Safety, FSmin = 1.0

Factor of Safety, FS = 1.24

References:

1 *Koerner, R.M., and Soong, T.Y.; "Analysis and Design of Veneer Cover Soils"; Geosynthetics International, 2005, Vol. 12, No.1, p28-49.*

2 *Soong, T.Y, and Koerner, R.M.; "Cover Soil Slope Stability Involving Geosynthetic Interfaces", GRI Report #18, 1996.*

3 *Koerner, R.M., and Daniel, D.; "Final Covers for Solid Waste Landfills and Abandoned Dumps", 1997.*

4 *Soong, T.Y, and Koerner, R.M.; "The Design of Drainage Systems over Geosynthetically Lined Slopes"; , GRI Report #19, 1997.*

5 *Koerner, G.R., Narejo, D.; "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces"; GRI Report #30, 2005.*

6 *U.S.E.P.A.; "RCRA Substitute D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities"; EPA/600/R-95/051, April, 1995.*

7 *Map on Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years, USGS Map, Oct. 2002.*

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Project:
P.N.: 2018-3854 **Page:** 5 of 5
By: JCA **Date:** 10-Oct-19
Checked: **Date:** 07/04/20
Subject: Cap System - Finite (Veneer) Slope Analysis

Caterpillar Performance Handbook (Edition 32, October 2001)

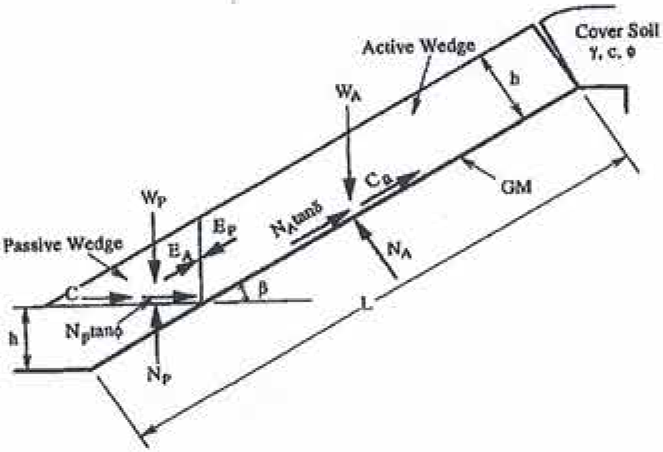
Model	Unit	D4G LGP Hystat	D6R	D6R LGP	D7R LGP Series II	D8R	D9R	D10R	***D6N LGP****
Weight of Equipment, W_b	lb	17,877	40,400	45,600	60,300	82,850	107,670	144,200	***39,112***
Length of Equipment Track, w	in	80.9	103	128	125	126	137	153	***122.7***
	ft	6.7	8.6	10.7	10.4	10.5	11.4	12.8	***10.2***
Width of Equipment Track, b	in	25	22	36	36	22	24	24	***33.07***
	ft	2.1	1.8	3.0	3.0	1.8	2.0	2.0	***2.8***
Ground contact area, calculated	in^2	4,045	4,532	9,216	9,000	5,544	6,576	7,344	***8,115***
	ft^2	28.1	31.5	64.0	62.5	38.5	45.7	51.0	***56.4***
Ground contact area, from book	in^2	4,045	4,518	9,194	9,029	5,565	6,569	7,321	***8,122***
	ft^2	28.1	31.4	63.8	62.7	38.6	45.6	50.8	***56.4***
Ground pressures, from book	psi	4.11	8.82	4.94	6.55	14.67	16.08	19.63	***4.8***
	psf	592	1270	711	943	2112	2316	2827	***691***
Ground pressures, calculated	psi	4.42	8.91	4.95	6.70	14.94	16.37	19.64	***4.82***
	psf	636	1,284	713	965	2,152	2,358	2,827	***694***

Reference

1 *D6N track-type tractor product literature; www.cat.com.*

REFERENCE 1 pg 1/5

Case 1: Drained



Limit equilibrium forces in a finite length slope analysis for a uniformly thick cover soil.

$$\boxed{W_A = \gamma_{moist} \cdot h^2 \cdot \left[\frac{L}{h} - \frac{1}{\sin\beta} + \frac{\tan\beta}{2}\right]}$$

$$\boxed{W_P = \frac{h^2 \cdot \gamma_{moist}}{\sin 2\beta}} \quad \boxed{N_A = W_A \cdot \cos\beta}$$

$$\boxed{C_a = c_a \cdot \left(L - \frac{h}{\sin\beta}\right)} \quad \boxed{C = \frac{c \cdot h}{\sin\beta}}$$

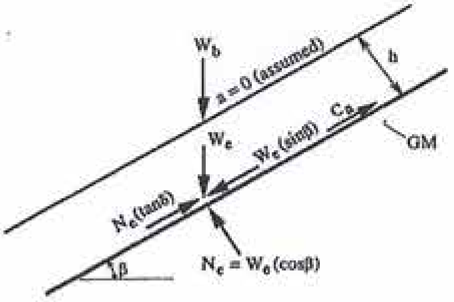
$$\boxed{a = (W_A - N_A \cdot \cos\beta) \cdot \cos\beta} \quad \boxed{c = (N_A \cdot \tan\delta + C_a) \cdot \sin^2\beta \cdot \tan\phi}$$

$$\boxed{b = -[(W_A - N_A \cdot \cos\beta) \cdot \sin\beta \cdot \tan\phi + (N_A \cdot \tan\delta + C_a) \cdot \sin\beta \cdot \cos\beta + \sin\beta \cdot (C + W_P \cdot \tan\phi)]}$$

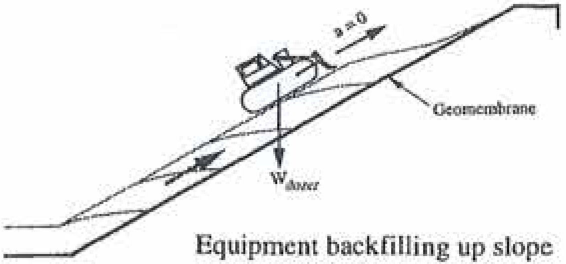
$$\boxed{FS = \frac{-b + \sqrt{b^2 - 4a \cdot c}}{2a}}$$

REFERENCE 1 pg 2/5

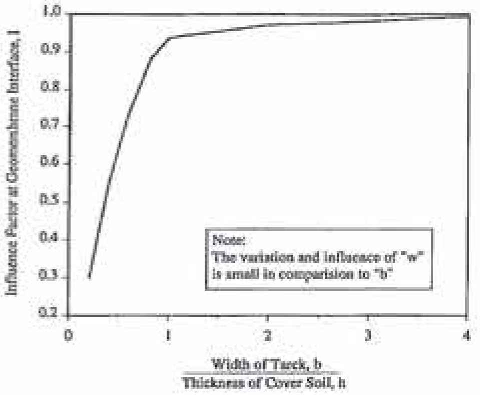
Case 2: Drained, Equipment Pushing Upslope



Equipment moving up slope
(load with no assumed acceleration)



Equipment backfilling up slope
(the recommended method)



Note:
The variation and influence of "w" is small in comparison to "b"

- W_A, W_P, N_A, Ca, C, and FS same as Case 1

$$q = \frac{W_b}{(2 \cdot w \cdot b)}$$

$$W_e = q \cdot w \cdot I$$

$$N_e = W_e \cdot \cos\beta$$

$$a = [(W_A + W_e) \cdot \sin\beta] \cdot \cos\beta$$

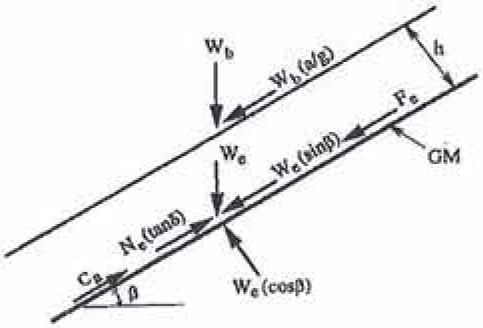
$$c = [(N_e + N_A) \cdot \tan\delta + C_a] \cdot \sin\beta \cdot \tan\phi$$

$$b = -\{[(N_e + N_A) \cdot \tan\delta + C_a] \cdot \cos\beta + [(W_A + W_e) \cdot \sin\beta] \cdot \sin\beta \cdot \tan\phi + (C + W_P \cdot \tan\phi)\}$$

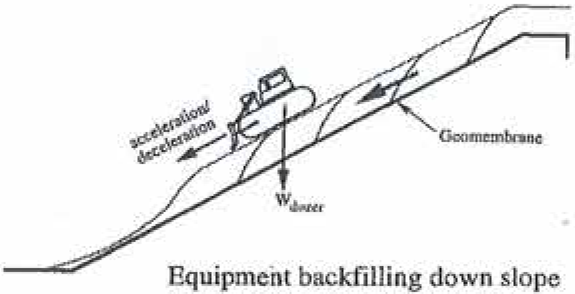
REFERENCE 1

pg 3/5

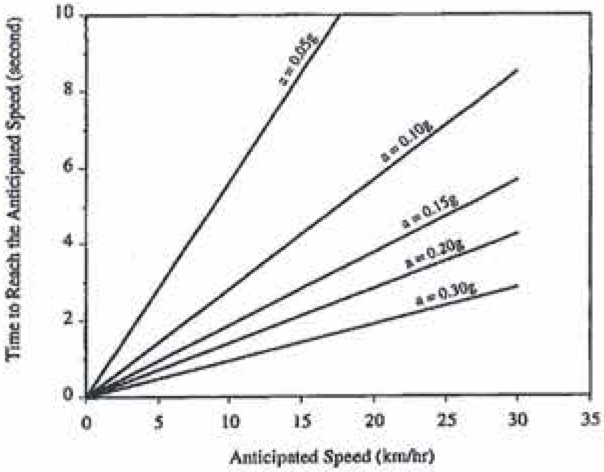
Case 3: Drained, Equipment Pushing Downslope



Equipment moving down slope
(load plus acceleration or deceleration)



Equipment backfilling down slope
(method is not recommended)



- W_A, W_P, N_A, Ca, C, and FS same as Case 1

- We, q, and Ne same as Case 2

$$\boxed{F_e = W_e \cdot \left(\frac{a}{g}\right)}$$

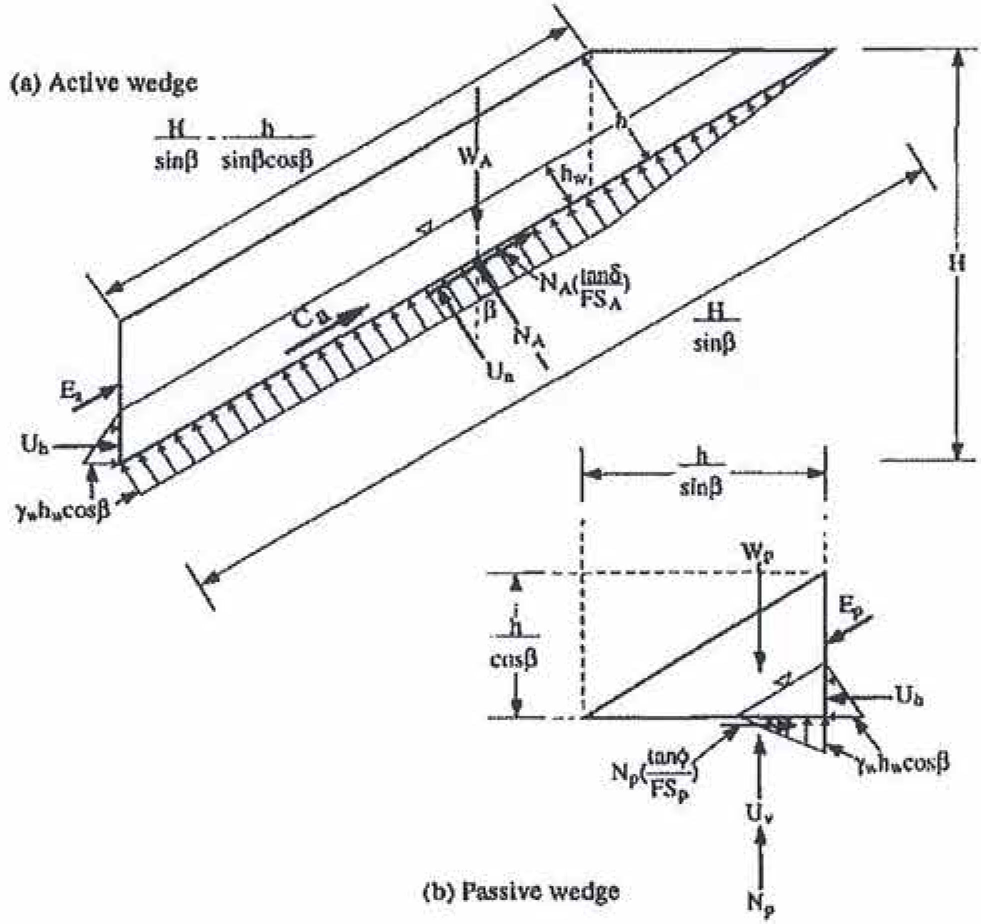
$$\boxed{a = [(W_A + W_e) \cdot \sin\beta + F_e] \cdot \cos\beta}$$

$$\boxed{c = [(N_e + N_A) \cdot \tan\delta + C_a] \cdot \sin\,\beta \cdot \tan\phi}$$

$$\boxed{b = -\{[(N_e + N_A) \cdot \tan\delta + C_a] \cdot \cos\beta + [(W_A + W_e) \cdot \sin\beta + F_e] \cdot \sin\beta \cdot \tan\phi + (C + W_P \cdot \tan\phi)\}}$$

REFERENCE pg 4/5

Case 5: Parallel Seepage Build-up



$$W_A = \frac{\gamma_{moist} \cdot (h-h_w) \cdot \left[2H \cdot \cos\beta - (h+h_w)\right]}{\sin 2\beta} + \frac{\gamma_{sat} \cdot h_w \cdot (2H \cdot \cos\beta - h_w)}{\sin 2\beta}$$

$$W_P = \frac{\gamma_{moist} \cdot (h^2 - h_w{}^2) + h_w{}^2 \cdot \gamma_{sat}}{\sin 2\beta}$$

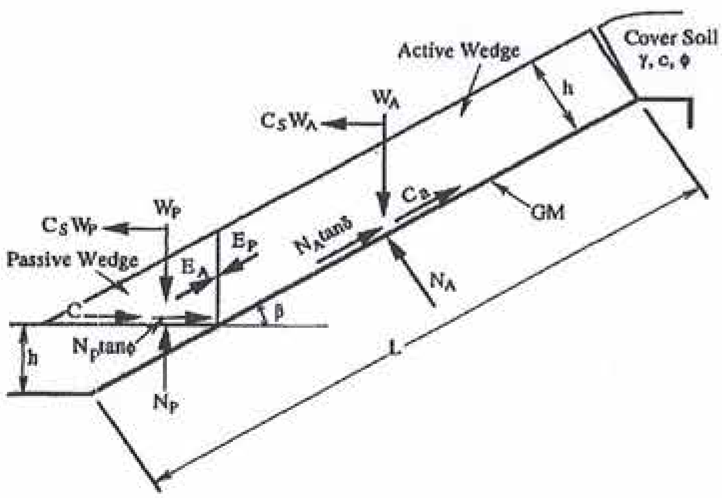
- Ca, C, and FS same as Case 1
- a, b, c, U_V, and N_A same as Case 4

$$U_N = \frac{\gamma_w \cdot h_w \cdot \cos\beta \cdot (2H \cdot \cos\beta - h_w)}{\sin 2\beta}$$

$$U_h = \frac{\gamma_w \cdot h_w{}^2}{2}$$

REFERENCE 1 pg 5/5

Case 6: Drained, Seismic Affect



- Wa, Wp, Na, Ca, C, and FS same as Case 1

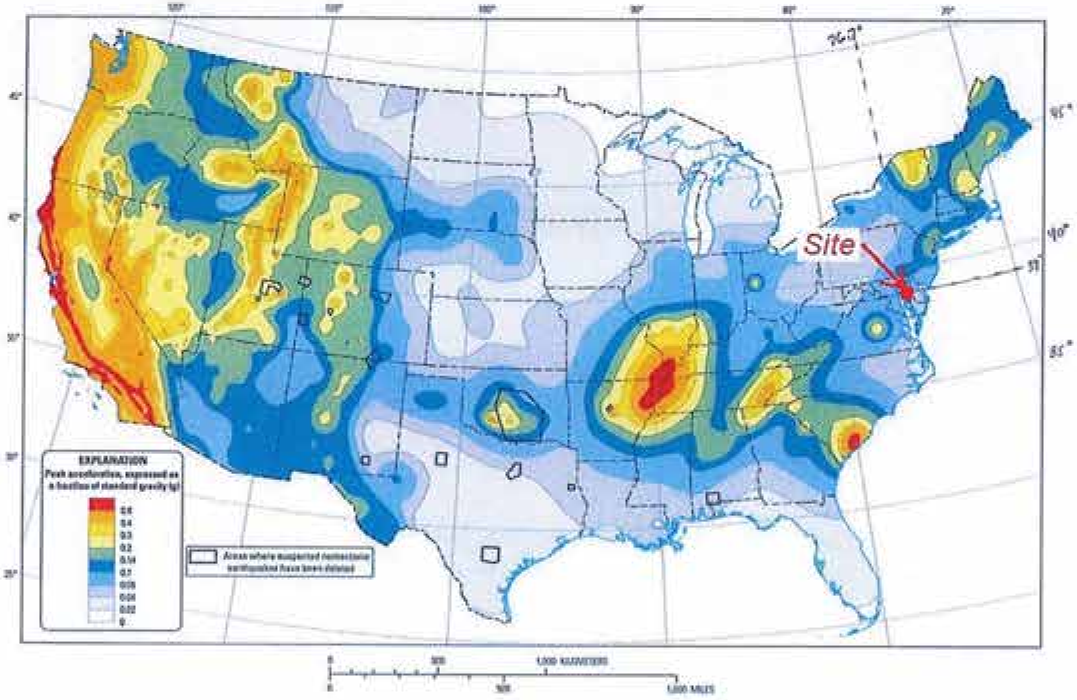
$$\boxed{a = (C_s \cdot W_A + N_A \cdot \sin\ \beta) \cdot \cos\beta + C_s \cdot W_P \cdot \cos\beta}$$

$$\boxed{c = (N_A \cdot \tan\delta + C_a) \cdot \cos\beta \cdot \sin\ \beta \cdot \tan\phi}$$

$$\boxed{b = -[(C_s \cdot W_A + N_A \cdot \sin\ \beta) \cdot \sin\ \beta \cdot \tan\phi + (N_A \cdot \tan\delta + C_a) \cdot \cos^2\beta + (C + W_P \cdot \tan\phi) \cdot \cos\beta]}$$

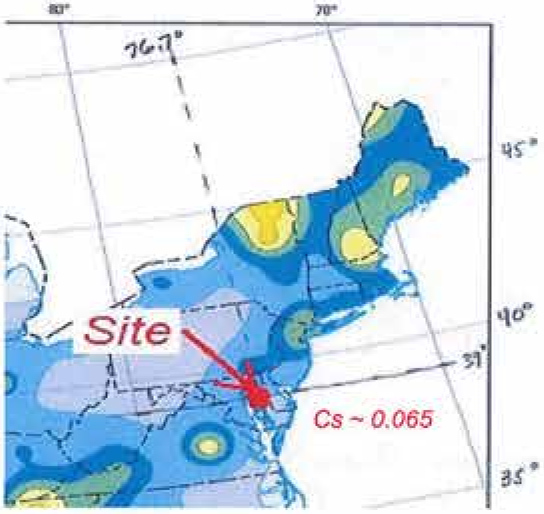
REFERENCE 7 pg 1/1

Case 6: Drained, Seismic Affect (cont.)



Two-percent probability of exceedance in 50 years map of peak ground acceleration

https://earthquake.usgs.gov/hazards/hazmaps/



Approximate Site Location

Two-percent probability of exceedance in 50 years map of peak ground acceleration

https://earthquake.usgs.gov/hazards/hazmaps/

ATTACHMENT 9H

Closure Cap Isolated Settlement Evaluation

ADVANCED GeoServices
a Montrose Environmental Group company

Subject: Cap System, Isolated Settlement		
Job No. 2018-3854	**Made by:** JCA	**Date** 06/19/20
Ref.	**Checked by:** VEF	**Sheet** 1 **of** 1

Reviewed by PGS 09/01/2021

These calculations are still acceptable for the revised design.

Objective:

Determine the maximum allowable isolated settlement of the cap system.

Design Approach:

1. Assume an isolated settlement will present as a spherical shaped "bowl" in the surface of the capped landfill. Consequently, such a shape can be addressed as if it as a horizontal curve, and using traditional horizontal curve design equations. (Reference 1) Use these equations to calculate the strain (%) experienced by the textured, linear low density polyethylene (LLDPE-T) geomembrane in the cap system.
2. Any amount of strain can be experienced by an infinite number of combinations of observed settlement and length over which the settlement occurs (span).
3. Set the maximum allowable strain at 8%. (Reference 2)
4. Develop a table that can be used by landfill operations personnel to determine if observed isolated settlement has resulted in an exceedance of the maximum allowable strain.

Calculation:

See attached calculation sheet for example calculations.

Conclusion:

See attached table developed for use by landfill operations personnel.

References:

1. Linburg, Michael R.; *"Civil Engineering Reference Manual"*; 6th Ed., 1992, Section 17-10.
2. Peggs, et al; *"Assessment of Maximum Allowable Strains In Polyethylene and Propylene Geomembranes"*; Geo-Frontiers Congress 2005.
3. Qian, X., Koerner, R.M., Gray, D.H., (2002). *"Geotechnical Aspects of Landfill Design and Construction"*; Prentice Hall; Upper Saddle River, NJ; 1st Ed., Sect. 4.7.2.

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Project:
P.N.: 2018-3854
Page: 1 of 1
By: JCA
Date: 19-Jun-20
Checked:
Date: 07/4/20
Subject: Cap System, Isolated Settlement

Cap System - Isolated Settlement

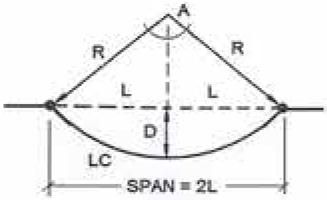
Reviewed by PGS 09/01/2021

Description

Determine the maximum allowable isolated settlement of the cap system.

Variables

Measured depth of subsidence =	D	ft
Shortest measured distance where D occurs, = original length of geomembrane =	SPAN	ft
(SPAN)/2 =	L	ft
Radius of the resultant curvature of depression =	R	ft
Angle of the resultant curvature of depression =	A	deg
Length of elongated geomembrane =	LC	ft
Percent Strain of the geomembrane at yield or break =	E	%
Calculated percent strain of elongated geomembrane =	E'	%



Equations (References 1 and 3)

(1) $LC = (RA)/57.32$

(2a) $R^2 = L^2 + (R-D)^2$

(2b) $R = (D^2 + L^2)/(2D)$

(3a) $SPAN = 2L = 2R(\sin(A/2))$

(3b) $A = 2(\sin^{-1}(2LD/(D^2+L^2)))$

(4) E = (change in length)/(original length)

Since there are an infinite number of combinations of D and SPAN that could be observed, the maximum allowable isolated settlement of the cap system is related to the resulting strain of the geomembrane, rather than an observed settlement amount, D. Therefore, use these equations to develop a series of graphs to be used by operations personnel to evaluate observed isolated settlement(s) of the cap system.

Cap System Geomembrane

Material = 40-mil LLDPE-T
Maximum Strain, E_{max} = 8.0 % (Reference 2)

Example Calculations

Example 1

Measured depth of subsidence, D =	1.0	ft
Shortest measured distance where D occurs, = original length of geomembrane, SPAN =	5.0	ft
(SPAN)/2, L =	2.5	ft
Radius of the resultant curvature of depression, R =	3.6	ft
Angle of the resultant curvature of depression, A =	87.21	deg
Length of elongated geomembrane, LC =	5.5	ft
Calculated percent strain of elongated geomembrane, E' =	10.3	%

Example 2

Measured depth of subsidence, D =	2.25	ft
Shortest measured distance where D occurs, = original length of geomembrane, SPAN =	23.00	ft
(SPAN)/2, L =	11.5	ft
Radius of the resultant curvature of depression, R =	30.5	ft
Angle of the resultant curvature of depression, A =	44.28	deg
Length of elongated geomembrane, LC =	23.6	ft
Calculated percent strain of elongated geomembrane, E' =	2.5	%

Note: This analysis cannot be used for D > (SPAN/2).

References:

1 *"Civil Engineering Reference Manual"; Michael R. Linburg; 6th Ed., 1992, Section 17-10.*

2 *"Assessment of Maximum Allowable Strains In Polyethylene and Propylene Geomembranes"; Peggs, Schmucker, Carey; Geo-Frontiers Congress 2005.*

3 *Qian, X., Koerner, R.M., Gray, D.H., (2002). "Geotechnical Aspects of Landfill Design and Construction"; Prentice Hall; Upper Saddle River, NJ; 1st Ed., Sect. 4.7.2.*

Strain, E (%), as Related to Subsidence Span, SPAN (ft), and Subsidence Depth, D (in.), for 40-mil Textured LLDPE

		SPAN, ft							
		1	5	10	15	20	25	30	
D, in	1.25	2.6							
	1.75	5.9							
	2.11	**8.0**							
	2.50	**10.3**							
	3.00		0.6						
	6.00		2.6	0.6	0.3	0.1	0.1	0.0	
	9.00		5.9	1.5	0.6	0.3	0.2	0.1	
	10.50		**8.0**						
	12.00		**10.3**	2.6	1.1	0.6	0.4	0.3	
	18.00			5.9	2.6	1.5	0.9	0.6	
	21.00			**8.0**					
	24.00			**10.3**	4.6	2.6	1.7	1.1	
	30.00				7.2	4.1	2.6	1.8	
	31.60				**8.0**				
	36.00				**8.7**	5.9	3.8	2.6	
	42.00					**8.0**	5.1	3.5	
	48.00					**10.3**	6.6	4.6	
	52.70						**8.0**		
	54.00						**8.4**	5.9	
	60.00							7.2	
	63.10							**8.0**	
	66.00							**8.7**	
	72.00								

NOTES:

1 Combinations of SPAN and D that fall in the green zone indicate strains < 8% - acceptable.

2 Combinations of SPAN and D that fall in the red zone indicate strains > 8% - not acceptable.

Reviewed by PGS 09/01/2021

PRODUCT DATA SHEET

GSE UltraFlex Textured Geomembrane

GSE UltraFlex Textured is a co-extruded textured linear low density polyethylene (LLDPE) geomembrane available on one or both sides. It is manufactured from the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased frictional resistance, flexibility and elongation properties where differential or localized subgrade settlements may occur such as in a landfill closure application.

[*]

AT THE CORE:
An LLDPE geomembrane that is used in applications requiring increased frictional resistance, flexibility and elongation properties, such as landfill closures and mining applications.

Product Specifications

These product specifications meet GRI GM17

Tested Property	Test Method	Frequency	Minimum Average Value			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	40 36	60 54	80 72	100 90
Density, g/cm³ (max.)	ASTM D 1505	200,000 lb	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lb	60 250	90 250	120 250	150 250
Tear Resistance, lb	ASTM D 1004	45,000 lb	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lb	44	66	88	110
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	> 100	> 100	> 100	> 100
TYPICAL ROLL DIMENSIONS						
Roll Length(2), ft	Double-Sided Textured Single-Sided Textured		700 800	520 540	400 410	330 330
Roll Width(2), ft			22.5	22.5	22.5	22.5
Roll Area, ft²	Double-Sided Textured Single-Sided Textured		15,750 18,000	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:

- (1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Textured is available in rolls weighing approximately 4,000 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP] For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

ATTACHMENT 9I

Closure Cap Drainage Layer

ADVANCED GeoServices
a Montrose Environmental Group company

Subject: Cap System, Geocomposite Drainage Net Requirements		
Job No. 2018-3854	**Made by:** JCA	**Date** 06/19/20
Ref.	**Checked by:** VEF	**Sheet** 1 of 3

Reviewed by PGS 09/01/2021

Objective:

Determine various design parameters for the cap system.

Design Approach:

1. Two different slope conditions are included in the general landfill design: 25H:1V (4%) top, 3H:1V side slope, and 31H:1V (6.0%) bench sub-drainage.
2. Using various design parameters and estimated material characteristics, estimate the vertical load imposed on the geocomposite drainage net (GDN).
3. Consider manufacturer's data for a moderate compressive strength, high flow (GDN) product for use in the cap drainage system. (Reference 4)
4. Select mid-range reduction factors for use in calculating the allowable transmissivity and final thickness of the GDN to account for creep deformation of the GDN core, intrusion of the geotextile into the GDN core, chemical clogging of the GDN core and/or geotextile, and biological clogging of the GDN core and/or geotextile. Assume the GDN layer is saturated (full-flow) and under laminar flow conditions. (Reference 1)
5. The minimum product of all reduction factors is set at a value of 8, and the minimum factor of safety is set at a value of 8. (Reference 2)
6. Select a maximum distance between cap drains (this can vary in conjunction with other parameters).
7. Estimate the allowable transmissivity, final thickness, and allowable permeability (hydraulic conductivity) of the GDN, and the maximum permeability of the cover soil layer overlying the GDN.

Discussion:

Darcy's Law is typically used to analyze flow through geosynthetics, as follows:

$$Q = k\,i\,A = k\,i\,w\,t$$

Setting transmissivity, $\theta = k\,t$,

$$Q = \theta\, i\, w \qquad or \qquad Q = \theta\, i \;\; \textit{(using a unit width)}$$

and,

$$\theta = Q/iw \qquad or \qquad k\,t = Q/i \;\; \textit{(using a unit width)}$$

where: Q = flow rate, cm^3/sec;
k = coefficient of permeability, cm/sec;

i = hydraulic gradient;
A = cross-sectional area of flow, cm^2;
θ= transmissivity, cm^2/sec;
w = width, cm; and,
t = thickness, cm.

For a given flow rate needed, Q, and an established flow area, A (also defined by $A = w\ t$), the permeability, k, of the GDN is inversely related to the hydraulic gradient, i. That is, as hydraulic gradient increases, permeability decreases.

Calculation:

Landfill Top (25H:1V = 4% slope):

For this arrangement, the longest slope length is approximately 130 ft. Based on the attached calculation sheet, to maintain a factor of safety of at least 8, a maximum permeability of the cover soils overlying the GDN was calculated to be 1.0x10^{-5} cm/sec. Additionally, the allowable transmissivity, final thickness, and allowable permeability (hydraulic conductivity) of the GDN were calculated to be 8.13x10^{-4} m^2/sec, 0.64 cm, and 12.80 cm/sec, respectively. The calculated factor of safety is 8.2 The flow calculated from the landfill top is added to the flow from the sideslope (next section) to allow to allow the combined flows to be managed in the sideslope cap drainage layer.

Landfill Side Slopes (3H:1V = 33% slope):

For this arrangement, the longest slope length is approximately 115 ft. The maximum permeability of the cover soil overlying the GDN was presumed to be the same as the top of the landfill, 1x10^{-5} cm/sec. Additionally, the flow from the landfill top was added to the combined flows to be managed in the sideslope cap drainage layer. Based on the attached calculation sheet, the allowable transmissivity, final thickness, and allowable permeability (hydraulic conductivity) of the GDN were calculated to be 9.26x10^{-4} m^2/sec, 0.64 cm, and 14.58 cm/sec, respectively. With these parameters, a factor of safety of at least 8 is provided.

Conclusion:

For the given GDN product characteristics, and the estimated soil characteristics, limiting the permeability of the cover soils overlying the GDN to a maximum of 1x10^{-5} cm/sec, a minimum factor of safety of 8 can be maintained. Since the flow from the landfill top was included in the sideslope flow, and the factor of safety of landfill top itself was 8.2, cap pipe drains are not proposed. The calculated GDN parameters of final thickness and permeability (hydraulic conductivity) can be used in other calculations as appropriate.

Subject: Cap System, Geocomposite Drainage Net Requirements		
Job No. 2018-3854	**Made by:** JCA	**Date** 06/19/20
Ref.	**Checked by:** VEF	**Sheet** 3 of 3

Reviewed by PGS 09/01/2021

References:

1. Zhao, A., and Richardson, G.M.,(2003). *"Geocomposite Drains for Side Slope Stability in Landfill Covers"*, 2000.
2. Richardson, G.N, and Pavlik, K.L.; *"Lessons Learned From Failure: Landfill Covers"*; GFR Oct/Nov 2004; pp 31-33.
3. *"Geotechnical Aspects of Landfill Design and Construction";* Qian, Koerner, and Gray; 1st Ed., 2002; Sect 8.4.3.
4. Manufacturer's data, various.
5. Site specific data, estimated.

ADVANCED GeoServices
a Montrose Environmental Group company

Project:
P.N.: 2018-3854 **Page:** 1 of 2
By: JCA **Date:** 18-Jun-20
Checked: VEF VEF **Date:** 7-15-20
Subject: Cap Drainage System
Geocomposite Drainage Net Requierments
Landfill Top

Cap Drainage System - Landfill Top

Description
Determine various design parameters for the cap system for the landfill top to maintain a minimum factor of safety with respect to cap drainage.

Slope Information

Maximum slope length between drains, L = 130 ft = 39.6 m
Slope, H = 25 to 1V = 0.040 ft/ft
Slope angle, β = 2.29 deg

Vertical Loads

Cap System Thickness, D_1 = 2 ft
Overall Cap System Unit Weight, γ_1 = 115 pcf
Approximate Overall Cap System Pressure, σ_1 = 230 psf
Approximate Total Vertical Pressure, $\sigma_T = \sum\sigma$ = 230 psf = 11.0 kPa

Geocomposite Drainage Net Product *(Reference 4)*

Product Type = GSE TenFlow 350
Estimated Ultimate Transmissivity from Manufacturer's Data, θ_U = 6.50E-03 m^2/sec @ gradient, i_{in} = 0.1

Reduction Factors *(References 1 and 3)*

Creep deformation of the drainage core itself and/or intrusion of the adjacent geotextile into the drainage core space, RF_{CR} = 1.4 >>>> *Range: 1.1 to 1.4*

Elastic deformation of the adjacent geotextile intruding into the drainage core space, RF_{IN} = 1.5 >>>> *Range: 1.3 to 1.5*

Chemical clogging of the adjacent geotextile or the drainage core space, RF_{CC} = 1.2 >>>> *Range: 1.0 to 1.2*

Biological clogging of the adjacent geotextile or the drainage core space, RF_{BC} = 1.5 >>>> *Range: 1.2 to 1.5*

Mathematical product of all RFs, XRF = 3.8 *XRF_{min} =* 8 (Reference 2)
XRF = 8

Allowable Transmissivity *(Reference 1)*

Allowable transmissivity, $\theta_{all} = \theta_U / XRF$ = 8.13E-04 m^2/sec

Water Infiltration Quantity *(Reference 1)*

Permeability of cover soil, k_c = 1.00E-05 cm/sec = 1.00E-07 m/sec
Water infiltration through cover soil, $Q_{in} = (k_c)(L)$ 4.0E-06 m^2/sec

Geocomposite Capacity *(References 1 and 2)*

Geocomposite allowable transmissivity, θ_{all} = 8.13E-04 m^2/sec = 8.13E+00 cm^2/sec
Surface Flow Gradient, i = 0.04
Flow capacity of the geocomposite, $Q_{out} = \theta_{all}(i)$ = 3.25E-05 m^2/sec

Minimum Factor of Safety FS_{min} = 8 (Reference 2)
Factor of Safety $FS = Q_{out}/Q_{in}$ = 8.20

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Project:
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By: JCA **Date:** 18-Jun-20
Checked: VEF VEF **Date:** 7.15.20
Subject: Cap Drainage System
Geocomposite Drainage Net Requierments
Landfill Top

Geocomposite Drainage Net Thickness *(Reference 1)*

Starting thickness, Ti =	350.0	mil	=	0.35	in
Final thickness, Tf = Ti/RF $_{CR}$ =	0.25	in	=	0.64	cm

Geocomposite Drainage Net Hydraulic Conductivity *(Reference 1)*

Allowable hydraulic conductivity, $K_{all} = \theta_{all}/Tf =$ 12.80 cm/sec

References:

1 *Zhao, A., and Richardson, G.M.,(2000). "Geocomposite Drains for Side Slope Stability in Landfill Covers", 2003.*
2 *"Lessons Learned From Failure: Landfill Covers"; Richardson, G.N, and Pavlik, K.L.; GFR Oct/Nov 2004; pp 31-33.*
3 *"Geotechnical Aspects of Landfill Design and Construction";* Qian, Koerner, and Gray; 1st Ed., 2002; Sect 8.4.3.
4 *Manufacturer's data.*
5 *Site specific data, estimated.*

ADVANCED GeoServices
a Montrose Environmental Group company

Project:
P.N.: 2018-3854 **Page:** 1 of 2
By: JCA **Date:** 18-Jun-20
Checked: VEF VEJ **Date:** 7·15·20
Subject: Cap Drainage System
Geocomposite Drainage Net Requilerments
Longest Landfill Sideslope + Top

Cap Drainage System - Longest Side Slope + Top

Description
Determine various design parameters for the cap system at the longest sideslsope to maintain a minimum factor of safety with respect to cap drainage. Flow from the landfill top is included.

Slope Information

Maximum slope length between drains, L = 115 ft = 35.1 m
Slope, H = 3 to 1V = 0.333 ft/ft
Slope angle, β = 18.43 deg

Vertical Loads

Cap System Thickness, D_1 = 2 ft
Overall Cap System Unit Weight, γ_1 = 115 pcf
Approximate Overall Cap System Pressure, σ_1 = 230 psf
Approximate Total Vertical Pressure, $\sigma_T = \sum\sigma$ = 230 psf = 11.0 kPa

Geocomposite Drainage Net Product *(Reference 4)*

Product Type = GSE TenFlow 350
Estimated Ultimate Transmissivity from Manufacturer's Data, θ_U = 3.50E-03 m^2/sec @ hydraulic garadient, i_{in} = 1.0

Reduction Factors *(References 1 and 3)*

Creep deformation of the drainage core itself and/or intrusion of the adjacent geotextile into the drainage core space, RF_{CR} = 1.4 >>>> *Range: 1.1 to 1.4*

Elastic deformation of the adjacent geotextile intruding into the drainage core space, RF_{IN} = 1.5 >>>> *Range: 1.3 to 1.5*

Chemical clogging of the adjacent geotextile or the drainage core space, RF_{CC} = 1.2 >>>> *Range: 1.0 to 1.2*

Biological clogging of the adjacent geotextile or the drainage core space, RF_{BC} = 1.5 >>>> *Range: 1.2 to 1.5*

Mathematical product of all RFs, XRF = 3.8 *XRF_{min} =* 8 (Reference 2)
XRF = 8

Allowable Transmissivity *(Reference 1)*

Allowable transmissivity, $\theta_{all} = \theta_U / XRF$ = 9.26E-04 m^2/sec

Water Infiltration Quantity *(Reference 1)*

Permeability of cover soil, k_c = 1.00E-05 cm/sec = 1.00E-07 m/sec
Water infiltration through cover soil, $Q_{in} = (k_c)(L)$ 3.5E-06 m^2/sec
Water infiltration through cover soil of landfill top, Q_{in} = 4.00E-06 m^2/sec
Total Water Infiltration, Qin = 7.5E-06 m^2/sec

Geocomposite Capacity *(References 1 and 2)*

Geocomposite allowable transmissivity, θ_{all} = 9.26E-04 m^2/sec = 9.26E+00 cm^2/sec
Surface Flow Gradient, i = 0.33
Flow capacity of the geocomposite, $Q_{out} = \theta_{all}(i)$ = 3.09E-04 m^2/sec

Minimum Factor of Safety FS_{min} = 8
Factor of Safety $FS = Q_{out}/Qin$ = 41.12

Project:
P.N.: 2018-3854 **Page:** 2 of 2
By: JCA **Date:** 18-Jun-20
Checked: VEF VEF **Date:** 7.15.20
Subject: Cap Drainage System
Geocomposite Drainage Net Requlierments
Longest Landfill Sideslope + Top

Geocomposite Drainage Net Thickness *(Reference 1)*

Starting thickness, Ti = 350.0 mil = 0.35 in
Final thickness, $Tf = Ti/RF_{CR}$ = 0.25 in = 0.64 cm

Geocomposite Drainage Net Hydraulic Conductivity *(Reference 1)*

Allowable hydraulic conductivity, $K_{all} = \theta_{all}/Tf$ = 14.58 cm/sec

References:

1 *Zhao, A., and Richardson, G.M.,(2000). "Geocomposite Drains for Side Slope Stability in Landfill Covers", 2003.*
2 *"Lessons Learned From Failure: Landfill Covers"; Richardson, G.N, and Pavlik, K.L.; GFR Oct/Nov 2004; pp 31-33.*
3 *"Geotechnical Aspects of Landfill Design and Construction";* Qian, Koerner, and Gray; 1st Ed., 2002; Sect 8.4.3.
4 *Manufacturer's data.*
5 *Site specific data, estimated.*

REFERENCE 3
pg 1/1

RF_{IN} = reduction factor for elastic deformation, or intrusion, of the adjacent geosynthetics into the geonet's core space;
RF_{CR} = reduction factor for creep deformation of the geonet and adjacent geosynthetics into geonet's core space;
RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals in the geonet's core space; and
RF_{BC} = reduction factor for biological clogging in the geonet's core space.

Some guidelines as to various reduction factors to be used in different situations are given in Table 8.8. Note that these values are based on preliminary and relatively sparse information. Other reduction factors, such as installation damage, viscosity effects and temperature effects, could also have been incorporated. If needed, they can be included on a site-specific basis. An example problem follows, which illustrates the use of geonets and points out that high factors of safety are warranted in critical situations.

EXAMPLE 8.2

What is the allowable geonet flow rate to be used in the design of a secondary leachate collection (i.e., leak detection) system? Assume that laboratory testing at proper design load and proper hydraulic gradient gave a short-term between-rigid-plate index value of 1.2 gal/min-ft (14.9 liter/min-m).

Solution: Average values from Table 8.8 are used (however, note the large resulting reduction):

$$q_{\text{allow}} = \frac{q_{\text{ult}}}{RF_{IN} \times RF_{CR} \times RF_{CC} \times RF_{BC}} \tag{8.17}$$

$$= \frac{1.2}{1.75 \times 1.7 \times 1.75 \times 1.75}$$

$$= \frac{1.2}{9.11} = 0.13 \text{ gal/min-ft (1.6 liter/min-m)}$$

TABLE 8.8 Recommended Preliminary Reduction Factors for Determining Allowable Flow Rate or Transmissivity of Biplanar Geonets (Koerner, 1998)

Application Area	Reduction Factor Values			
	RF_{IN}	RF_{CR}*	RF_{CC}	RF_{BC}
Sport fields	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2	1.1 to 1.3
Capillary break	1.1 to 1.3	1.0 to 1.2	1.1 to 1.5	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill caps	1.3 to 1.5	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfill)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfill)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

*These values are sensitive to the density of the resin used in the geonet's manufacture. The higher the density, the lower the reduction factor. Creep of the covering geotextile(s) is a product-specific issue.

REFERENCE 4 pg 1/1

PRODUCT DATA SHEET

GSE TenFlow 350 mil Geocomposite

GSE TenFlow geocomposite consists of a 350 mil thick GSE TenFlow geonet heat-laminated on both sides with a GSE nonwoven needle-punched geotextile. TenFlow 350 is a T-shaped tri-axial geonet comprised of HDPE strands forming a three dimensional structure to provide planar water flow. The geotextile is available in mass per unit area range of 6 oz/yd² to 16 oz/yd². TenFlow 350 geocomposite provides high transmissivity in a soil environment.

AT THE CORE:
A 350 mil thick TenFlow geonet heat-laminated on both sides with a nonwoven needlepunched geotextile.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Roll Value[1]	
Geocomposite[6]			6 oz/yd²	8 oz/yd²
Transmissivity[2], gal/min/ft, (m²/sec) at gradient=0.1	ASTM D 4716	1/540,000 ft²	31.4 (6.5x10^{-3})	31.4 (6.5x10^{-3})
Transmissivity[2], gal/min/ft, (m²/sec) at gradient=0.33	ASTM D 4716	1/540,000 ft²	16.9 (3.5x10^{-3})	16.9 (3.5x10^{-3})
Ply Adhesion, lb/in	ASTM D 7005	1/50,000 ft²	0.5	0.5
Geonet Core[1,3] – GSE TenFlow				
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft²	350	350
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94
Carbon Black Content, %	ASTM D 4218	1/50,000 ft²	2.0	2.0
Creep Reduction Factor[4]	GRI-GC8	per formulation	1.05	1.05
Geotextile[1,3]				
Mass per Unit Area, oz/yd²	ASTM D 5261	1/90,000 ft²	6	8
Grab Tensile Strength, lb	ASTM D 4632	1/90,000 ft²	160	220
Grab Elongation, %	ASTM D 4632	1/90,000 ft²	50	50
CBR Puncture Strength, lb	ASTM D 6241	1/540,000 ft²	435	575
Trapezoidal Tear Strength, lb	ASTM D 4533	1/90,000 ft²	65	90
AOS, US sieve[1], (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)
Permittivity, sec⁻¹	ASTM D 4491	1/540,000 ft²	1.5	1.3
Water Flow Rate, gpm/ft²	ASTM D 4491	1/540,000 ft²	110	95
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	per formulation	70	70
NOMINAL ROLL DIMENSIONS[5]				
Roll Width, ft			12.5	12.5
Roll Length, ft			150	150
Roll Area , ft²			1,875	1,875

NOTES:
- [1] All geotextile properties are minimum average roll values except AOS which is maximum average roll value and UV resistance is typical value. Geonet core thickness is minimum average value.
- [2] Normal load of 1,000 psf, boundary condition: plate/sand/geocomposite/geomembrane/plate, water at 70°F for 1 hour.
- [3] Component properties prior to lamination.
- [4] 10,000 hour creep test under 2,000 psf at 70°F temperature.
- [5] Roll widths and lengths have a tolerance of ±1%
- [6] The TenFlow geonet has a circular aperture side and a cuspated side. The side with the circular apertures should be placed against the soil while the cuspated side should be placed against the geomembrane.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP] For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

ATTACHMENT 9J

Global Slope Stability

ADVANCED GeoServices
a Montrose Environmental Group company

ATTACHMENT 9J

Global Slope Stability

ADVANCED GeoServices a Montrose Environmental Group company	Subject: Global Slope Stability		
	Job No. 2018-3854	Made by: JCA	Date 07/19/20
	Ref.	Checked by: VEF	Sheet 1 of 6

PGS 9/2/21

1. Purpose

The purpose of this analysis is to evaluate the global slope stability of the proposed landfill.

2. Analysis Approach

a. This analysis relies on related project information, data, and design calculations, as appropriate.

b. The computer program SLOPE/W of GeoStudio by GEO-SLOPE International, Ltd., was used to evaluate potential circular and non-circular slip surfaces in a pseudo-static analysis using the Spence and Bishop methods.

c. Seismic factors were also included for evaluation. The analysis is called "pseudo-dynamic" with the addition of seismic factors.

d. This analysis included a sliding wedge analysis to evaluate the factor of safety against a mass sliding on the geosynthetics used in the liner and leachate collection system. Based on the anchor trench design, the interface between the HDPE-T ~~geosynthetic clay liner (GCL)~~ and the underlying subsoil has the lowest interface friction value of ~~23°~~ 18° (COHESIVE SATURATED). This value of δ was used in this analysis.

e. It is common in many engineering applications to consider 1.5 an acceptable minimum factor of safety for static conditions, and 1.0 for seismic conditions.

3. Locations of Interest

Cells 10 and 13 were selected for the settlement and bearing analyses for this project. Therefore, this analysis also focused on these cells. The scope of consideration was expanded to include immediately adjacent Cells 5D, and 16, as they share alignment along the long dimension of the cross-section used for these cells. Additionally, Cell 11 was added for the sliding wedge analysis.

4. Material Parameters

The generalized soil profiles developed for the settlement and bearing analyses were used here as well. Soil designations were simplified for the SLOPE/W program, and soil parameters assigned. Parameters were assigned consistent with the settlement and bearing analyses.

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Material Parameters for Cells 13 and 16			
Material	**Unit Weight, γ (pcf)**	**Cohesion, c (psf)**	**Internal Friction Angle, ϕ (deg)**
Sand S1	115.7	0	35.3
Sand S2	128.1	0	39.0
Sand S3	145.0	0	50.0
Sand S4	98.0	0	28.5
Clay C1	120.5	2,796	0
Clay C2	136.5	3,737	0
Clay C3	145.0	12,070	0
Clay C4	145.0	11,667	0
LLCS	115.0	0	28.0
CDD Waste	48.7	0	35.0
Protective Cover	115.0	0	28.0
Cap and Cover	115.0	0	28.0

Material Parameters for Cells 10 and 5D			
Material	**Unit Weight, γ (pcf)**	**Cohesion, c (psf)**	**Internal Friction Angle, ϕ (deg)**
Sand S1	103.1	0	29.6
Sand S2	120.7	0	37.3
Sand S3	102.0	0	29.4
Sand S4	145.0	0	55.4
Sand S5	145.0	0	55.4
Clay C1	136.5	3,737	0
Clay C2	145.0	4,365	0
LLCS	115.0	0	28.0
CDD Waste	48.7	0	35.0
Protective Cover	115.0	0	28.0
Cap and Cover	115.0	0	28.0

5. Seismic Impact

From the USGS (Ref. 3), the site was estimated to have maximum horizontal acceleration value of 0.065g. From the work of Hynes and Franklin (1984), as cited in USEPA guidance (Ref. 4), 50% of this value, 0.0325, was used for design. It was assigned as the horizontal coefficient, K_h. The vertical coefficient, K_v, is typically less than K_h, and is often insignificant.

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6. Circular Slip Surfaces

The following table provides a summary of the critical (minimum) factors of safety calculated for circular slip surfaces.

Minimum Factors of Safety
Circular Slip Surface, Pseudo-Static Condition

Cell/Slip Direction	Bishop Method	Spencer Method
1. Cell 16 into Cell 13	1.6	1.6
2. Cell 13 into Cell 16	1.6	1.6
3. Cell 5D into Cell 10	1.7	1.7
4. Cell 10 into Cell 5D	1.6	1.6

Graphical representations of items 1 and 4 and attached. It is noted these minimum factors of safety were associated with slip surfaces occurring within the cap layers. Circular slip circles extending into the waste had higher factors of safety. Slip surfaces extending deeper through the waste, and into the subsoils also had higher factors of safety. Additional graphics for circular slip circles extending through the cap layers, the waste and just into the subsoils for items 1 and 4 are also attached.

With the addition of the seismic factor, K_h, factors of safety were calculated as follows:

Minimum Factors of Safety
Circular Slip Surface, Pseudo-Dynamic Condition

Cell/Slip Direction	Bishop Method	Spencer Method
1. Cell 16 into Cell 13	1.4	1.4
2. Cell 13 into Cell 16	1.4	1.4
3. Cell 5D into Cell 10	1.6	1.6
4. Cell 10 into Cell 5D	1.5	1.5

7. Non-Circular Slip Surfaces

The following table provides a summary of the critical (minimum) factors of safety calculated for non-circular slip surfaces.

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Minimum Factors of Safety Non-Circular Slip Surface, Pseudo-Static Condition		
Cell/Slip Direction	**Bishop Method**	**Spencer Method**
1. Cell 16 into Cell 13	3.4	2.9
2. Cell 13 into Cell 16	1.7	4.0
3. Cell 5D into Cell 10	5.2	4.8
4. Cell 10 into Cell 5D	2.9	2.6

Graphical representations of items 1 and 4 are attached. With the addition of the seismic factor, K_h, factors of safety were calculated as follows:

Minimum Factors of Safety Non-Circular Slip Surface, Pseudo-Dynamic Condition		
Cell/Slip Direction	**Bishop Method**	**Spencer Method**
1. Cell 16 into Cell 13	3.0	2.9
2. Cell 13 into Cell 16	1.5	3.5
3. Cell 5D into Cell 10	4.3	3.9
4. Cell 10 into Cell 5D	2.5	2.3

8. Sliding Wedge Analysis

A sliding wedge analysis was performed for Cells 10, 5D, 13, and 11. It was not performed for Cell 16 since it was believed the overall geometry of Cell 16 would render acceptable results compared to the other cells analyzed. Cell 11, however, is the only cell to have the potential slip surface (~~GCL~~ HDPE-T to underlying subsoil) located on all three general areas of the cell – the sideslope at the sump, the floor, and the sideslope on the upgradient end of the cell.

Other cells have the floor and sump sideslope portions. In those cells, an active slip surface on the upgradient end of the floor was assumed to be oriented based on earth pressure theory (Bowles, Ref. 7), as follows:

$$\beta_a = 45 + \phi/2$$

Where ϕ is the angle of internal friction of the waste. The mass located upgradient of the floor is called the "active block". For the active block in cell 10, 5D, and 13, the resultant horizontal force, P_a, was calculated based on earth pressure theory equations provided by Sowers (Ref. 8). The resultant force P_a for the active block in Cell 11 was calculated as for other parts of the cell.

The mass located on the floor of the cell is called the "central block". The mass located on the sump sideslope is called the "passive block". The resultant forces from these blocks, P_c and P_p, were

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calculated based on a free body diagram of forces on a liner from Koerner (Ref. 9). Koerner and Soong (Ref. 10) added the a horizontal seismic factor. This also appears in Qian, *et al*, (Ref. 11).

The horizontal seismic force is added by multiplying the horizontal factor by the weight of each block, and using that as an additional force in the horizontal direction. This force is presumed to act towards the downslope direction.

Based on this analysis, the following tables summarize the factors of safety calculated.

Factors of Safety Sliding Wedge Slip Surface, Static		
Cell	**Static Factor of Safety**	**Dynamic Factor of Safety**
1. Cell 13	13.8 ✓	~~6.3~~ 5.2
2. Cell 11	~~3.9~~ 19.6	~~1.6~~ 7.1
3. Cell 5D	~~4.8~~ 3.7	~~3.3~~ 2.5
4. Cell 10	~~12.3~~ 9.3	~~6.0~~ 4.7

9. Conclusion

Based on the foregoing, the design parameters result in a minimum factor of safety of 1.5 being maintained.

6. References

1. Project Design Information
2. Related Project Calculations.
3. USGS; *"Two–Percent Probability of Exceedance in 50 Years Map of Peak Ground Acceleration"*; http://earthquake.usgs.gov/hazards/hazmaps/.
4. USEPA; *"RCRA Subtitle D (258) Seismic Design Guidance For Municipal Solid Waste Landfill Facilities"*, EPA/600/R-95/051; p 107.
5. GEO-SLOPE International, Ltd.; *"Stability Modeling with GeoStudio – SLOPE/W"* computer program.
6. USACOE; *"Slope Stability Design Manual"*; EM 1110-2-1902, Oct. 31, 2003; p3-2, Table 3-1.
7. Bowles, Joseph E.; *"Foundation Analysis and Design"*, The McGraw-Hill Companies, Inc., 5th Ed., 1996; Fig. 11-2, p 591.

8. Sowers, George F.; *"Introductory Soil Mechanics and Foundations: Geotechnical Engineering"*; Macmillan Publishing Co., Inc., 4th Ed., 1979; p 386, Eqn 9:4.

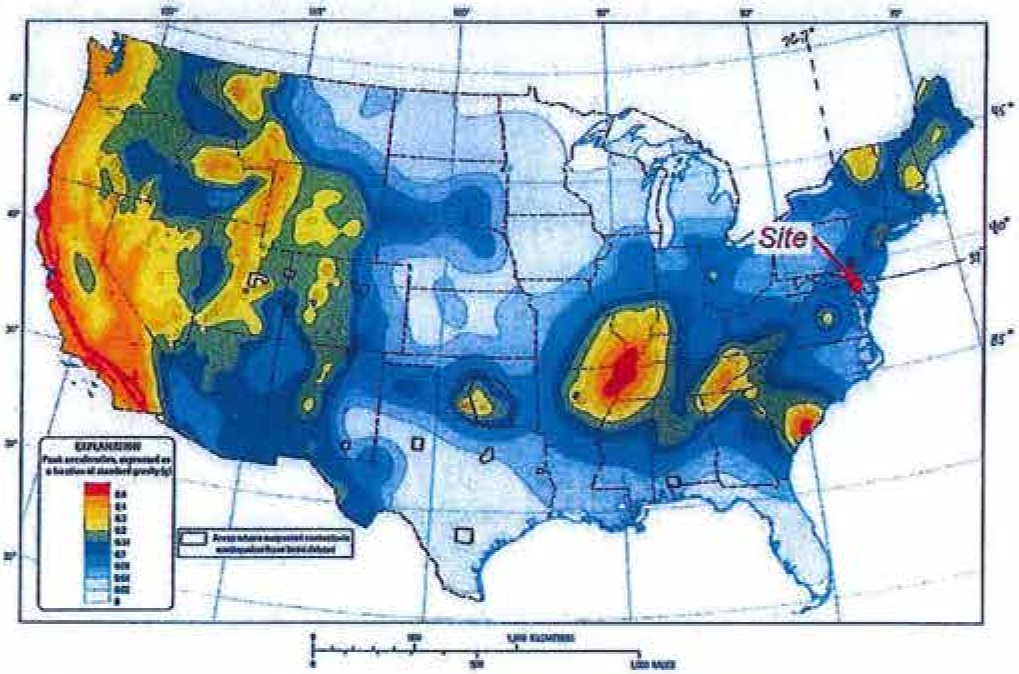
9. Koerner, Robert M.; *"Designing With Geosynthetics"*, 4th Ed., Prentice-Hall, Inc., 1998; p 479, Fig 5.28(a).

10. Koerner, Robert M., and Soong, T.Y.; *"Analysis and Design of Veneer Cover Soils"*; Geosynthetics International, 2005, Vol 12, No. 1; p 39. Fig 15.

11. Qian, Xuede; Koerner, Robert M.; Gray, Donald H.; *"Geotechnical Aspects of Landfill Design and Construction"*, Prentice-Hall, Inc., 2002; p 509, Fig 13.17.

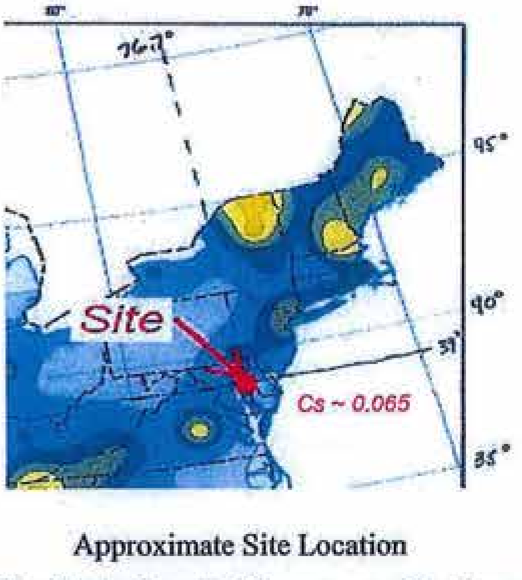
REFERENCE 3 pg 1/1

Case 6: Drained, Seismic Affect (cont.)



Two-percent probability of exceedance in 50 years map of peak ground acceleration

https://earthquake.usgs.gov/hazards/hazmaps/



Approximate Site Location

Two-percent probability of exceedance in 50 years map of peak ground acceleration

https://earthquake.usgs.gov/hazards/hazmaps/

REFERENCE 4 pg 1/1

Figure 6.5 shows the results of Newmark seismic deformation analyses performed by Hynes and Franklin (1984) using 387 strong motion records and 6 artificial accelerograms. Based upon this data and their experience with seismic response analyses of slopes and embankments, Hynes and Franklin (1984) concluded that slopes and embankments with a yield acceleration equal to half the peak ground acceleration would experience permanent seismic deformations of less than one meter (3 ft) in any earthquake, even for embankments where amplification of acceleration by a factor of three occurs. In the absence of amplification, or if amplification is taken into account in determining the peak acceleration, the Hynes and Franklin data suggest that deformations will remain less than 0.3 m (1 ft) for yield accelerations less than or equal to one-half the peak acceleration. Therefore, based upon the work of Hynes and Franklin, it appears that the maximum value of k_S may be determined as $k_S = 0.5 \cdot a_{max}/g$ to limit permanent seismic deformations to less than 0.3 m (1 ft), where a_{max} is peak horizontal acceleration at the ground surface for analyses of the liner system and at the top of the landfill for analyses of the cover system. a_{max} can be estimated either using the simplified methods presented in Section 4 of this guidance document or from the results of a seismic response analysis.

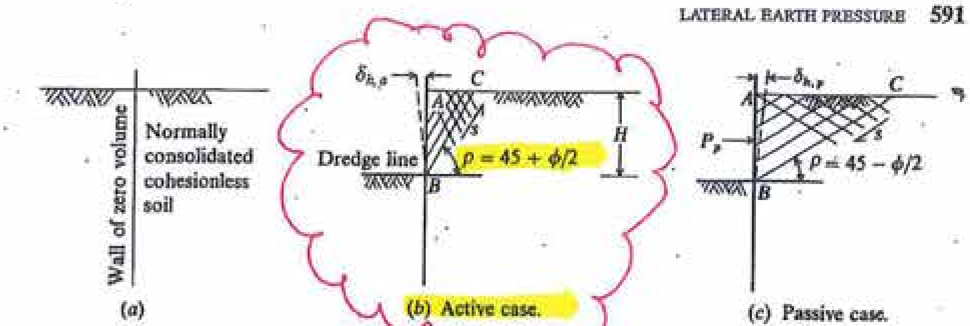
Step 3: Perform the pseudo-static stability analysis. If the minimum factor of safety, FS_{min}, exceeds 1.0 and 0.3 m (1 ft) of deformation is acceptable, the seismic stability analysis is completed.

Step 4: If the pseudo-static factor of safety is less than 1.0 or the acceptable deformation is less than 0.3 m (1 ft), perform a Newmark deformation analysis. This is done with the following three steps:

1) Calculate the yield acceleration, k_y. The yield acceleration is usually calculated in pseudo-static analyses using a trial and error procedure in which the seismic coefficient is varied until $FS_{min} = 1.0$ is obtained. The lowest yield acceleration for all possible failure surfaces passing through the liner, cover, and/or waste mass should be evaluated.

2) Calculate the permanent seismic deformation. The permanent seismic deformation may be calculated using either simplified design charts (e.g., Hynes and Franklin, 1984; Makdisi and Seed, 1978) or a formal time-history analysis in which the excursions of the average acceleration time history above the yield acceleration are double integrated.

REFERENCE 7 pg 1/1



(*a*) (*b*) Active case. (*c*) Passive case.

Figure 11-2 Idealization of active and passive earth pressure from a K_o developed by inserting a wall of zero thickness (and volume) into a soil mass as in (*a*).

It is also usual to use K_a for the $\tan^2$ term as shown previously in Fig. 4-2 and regularly used in this chapter. For the $\tan(45° + \phi/2)$ (passive) values of the next section, reverse the signs of the sine ratio terms.

Let us investigate the practical implications of Fig. 11-1 by using Fig. 11-2. In Fig. 11-2 we have inserted a wall of zero thickness into a normally consolidated; isotropic, cohesionless soil mass (we could use any soil but this simplifies the discussion). At this point we have a K_o stress state on the wall; and the lateral (soil-to-wall or wall-to-soil) pressure is, from the definition of K_o,

$$\sigma_3 = K_o \sigma_1$$

and is triangular since at any depth z the vertical pressure $\sigma_1 = \gamma z$. If we assume the soil is normally consolidated, K_o can be defined by one of the qualitative stress ratios of Fig. 11-1*a* as

$$K_o = \frac{OE}{OA}$$

Now let us excavate the soil on the left side of the wall of Fig. 11-2*a* to the depth H in Fig. 11-2*b* and *c*. If the wall does not shear off at point B (termed the *dredge line*) the wall will do one of the following:

1. Deflect laterally under the cantilever beam loading causing slip planes to form in the soil as in Fig. 11-1*c*. The lateral pressure $\sigma_h = \sigma_3$ on the Mohr's circle plot moves from E toward O. The Fig. 11-1*c* case develops since the K_o pressure exerted on the wall decreases as it deflects away from (but is followed by) the soil behind the wall.

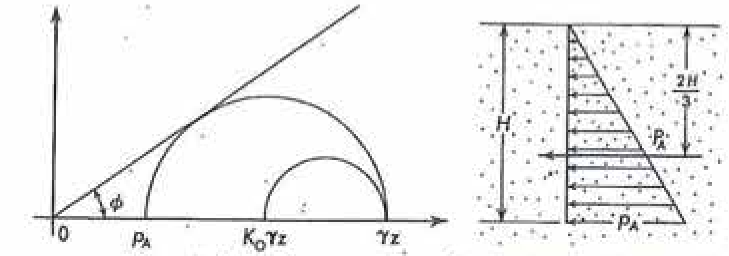
   If the wall displacement is sufficient, the lateral pressure reaches plastic equilibrium at OC and the wall pressure is a minimum (termed *active pressure case*) defined from Eq. (2-55) as

   $$\sigma_h = \sigma_1 K_a \qquad (\text{since } c = 0)$$

   This minimum pressure case can be explained from observing that the slip wedge is a minimum volume at 45° + $\phi/2$ from the horizontal. That is, the slope of the line from C to the point of tangency of Fig. 11-1*a* is also the slope of line BC of Fig. 11-2*b*. The shear resistance developed on line BC of Fig. 11-2*b* also reduces the tendency of the wedge ABC to push against the wall.

   If the lateral displacement ($\delta_{h,a}$) is limited (by a brace, prop, or wall stiffness), the wall pressure becomes indeterminate but is intermediate between the K_o and K_a pressures

REFERENCE 8 Pg 1/1



a. Mohr's circle

b. Distribution of horizontal earth pressure and location of resultant, P_A

Figure 9.3 *Active earth pressure in cohesionless soils, sands, and gravels.*

The expression $\tan^2[45-(\phi/2)]$ is often called the *coefficient of active earth pressure* and is given the symbol K_A. The state of shear failure accompanying the minimum earth pressure is called the *active state*. The resultant force P_A per unit of length of wall for the dry sand can be found by integrating the expression for active pressure or from the area of the pressure diagram:

★ $$P_A=\frac{\gamma H^2 K_A}{2} \tag{9:4}$$ ★

The action line is through the centroid at a depth of $2H/3$ (Fig. 9.3b).

If the soil is below water, neutral stress must again be considered. The effective active pressure is computed from the effective vertical pressure and K_A. The total is the sum of the effective and the neutral stress:

$$p'_A=(\gamma z-u)K_A \tag{9:5a}$$

$$p_A=(\gamma z-u)K_A+u \tag{9:5b}$$

When a dry cohesionless soil is inundated by a rising water table, the effective pressure is reduced to about half its original value. The total pressure, however, is approximately tripled. The location and magnitude of the resultant for a cohesionless soil below water is found by combining the effective and neutral stress diagrams.

Example 9:1

Compute the active earth pressure at a depth of 6 m or 19.7 ft in a clean sand whose angle of internal friction is 34° and which weighs 15.4 kN/m³ or 98 lb/ft³ drained and 20 kN/m³ or 127.4 lb/ft³ saturated.

1. The sand is dry throughout

$$p_A=\gamma z\ \tan^2=[45-(\phi/2)] \tag{9:3a}$$

$$p_A=15.4\times 6\times(0.532)^2=26.15\ \text{kN/m}^2$$

$$p_A=98\times 19.7\times(0.532)^2=546\ \text{lb/ft}^2.$$

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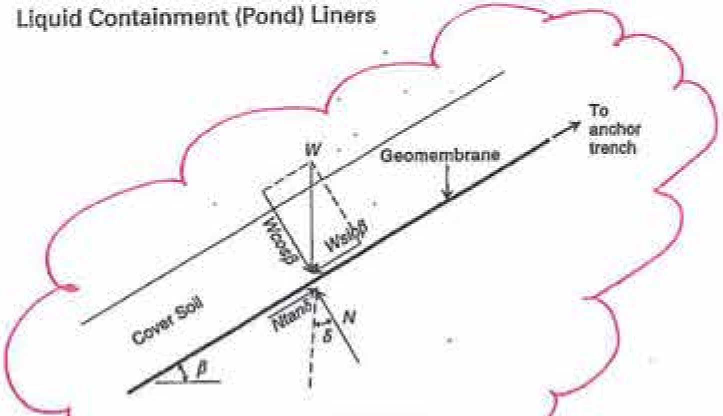
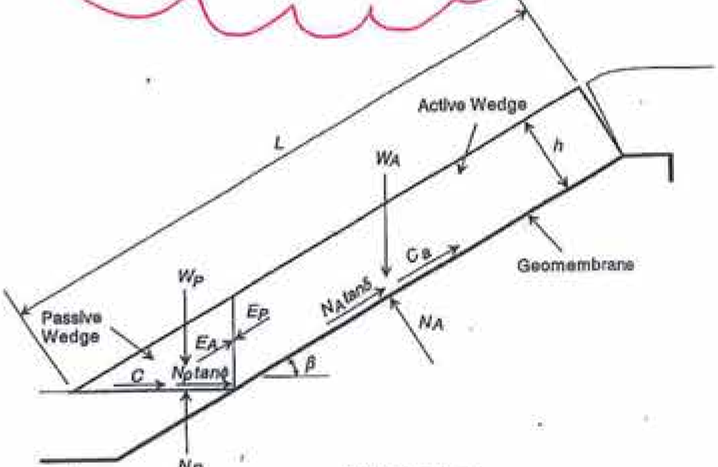
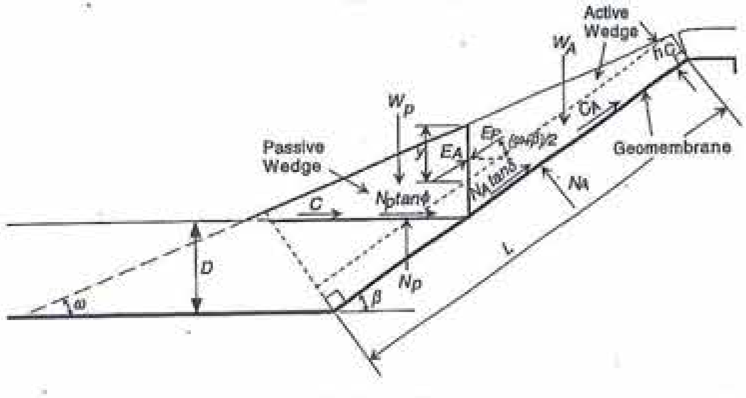


(a) Infinite slope



(b) Finite slope



(c) Tapered slope

Figure 5.28 Schematic diagrams for forces involved with cover soils on geomembrane-lined slopes: (a) infinite slope; (b) finite slope with uniform cover soil thickness; (c) finite slope with tapered cover soil thickness.

REFERENCE 11 pg 1/1

regulations require such an analysis for sites that have a probability of ≥ 10% of experiencing a 0.10-g peak horizontal acceleration within 250 years. For the continental United States, this includes not only the western states, but major sections of the Midwest and northeast states, as well. If practiced worldwide, such a criterion would have huge implications.

The seismic analysis of cover soils of the type under consideration in this section is a two-part process:

- **(i)** The calculation of a *FS*-value using a pseudostatic analysis via the addition of a horizontal force acting at the centroid of the cover soil cross section.
- **(ii)** If the *FS*-value in the above calculation is less than 1.0, a permanent deformation analysis is required. The calculated deformation is then assessed in light of the potential damage to the cover soil section and is either accepted, or the slope requires an appropriate redesign. The redesign is then analyzed until the situation becomes acceptable.

The *first part* of the analysis is a pseudostatic approach that follows the previous examples except for the addition of a horizontal force at the centroid of the cover soil in proportion to the anticipated seismic activity. It is first necessary to obtain an average seismic coefficient (C_S) from a representative seismic zone map (e.g., as in Algermissen, 1969). Such maps are available on a worldwide basis. The value of C_S is nondimensional and is a ratio of the bedrock acceleration to gravitational acceleration. This value of C_S is modified using available computer codes such as "SHAKE" (see Schnabel et al., 1972) for propagation to the site and then to the landfill cover as shown in Figure 13.17. The computational process within such programs is quite intricate. For detailed discussion, see Seed and Idriss (1982) and Idriss (1990). The analysis is nonetheless similar to those previously presented.

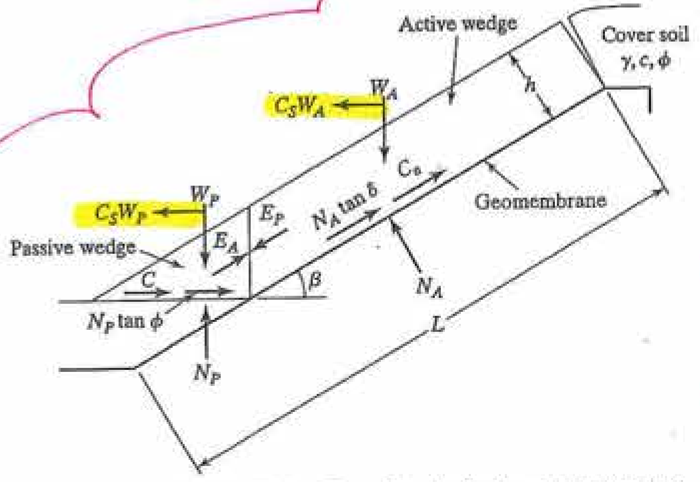
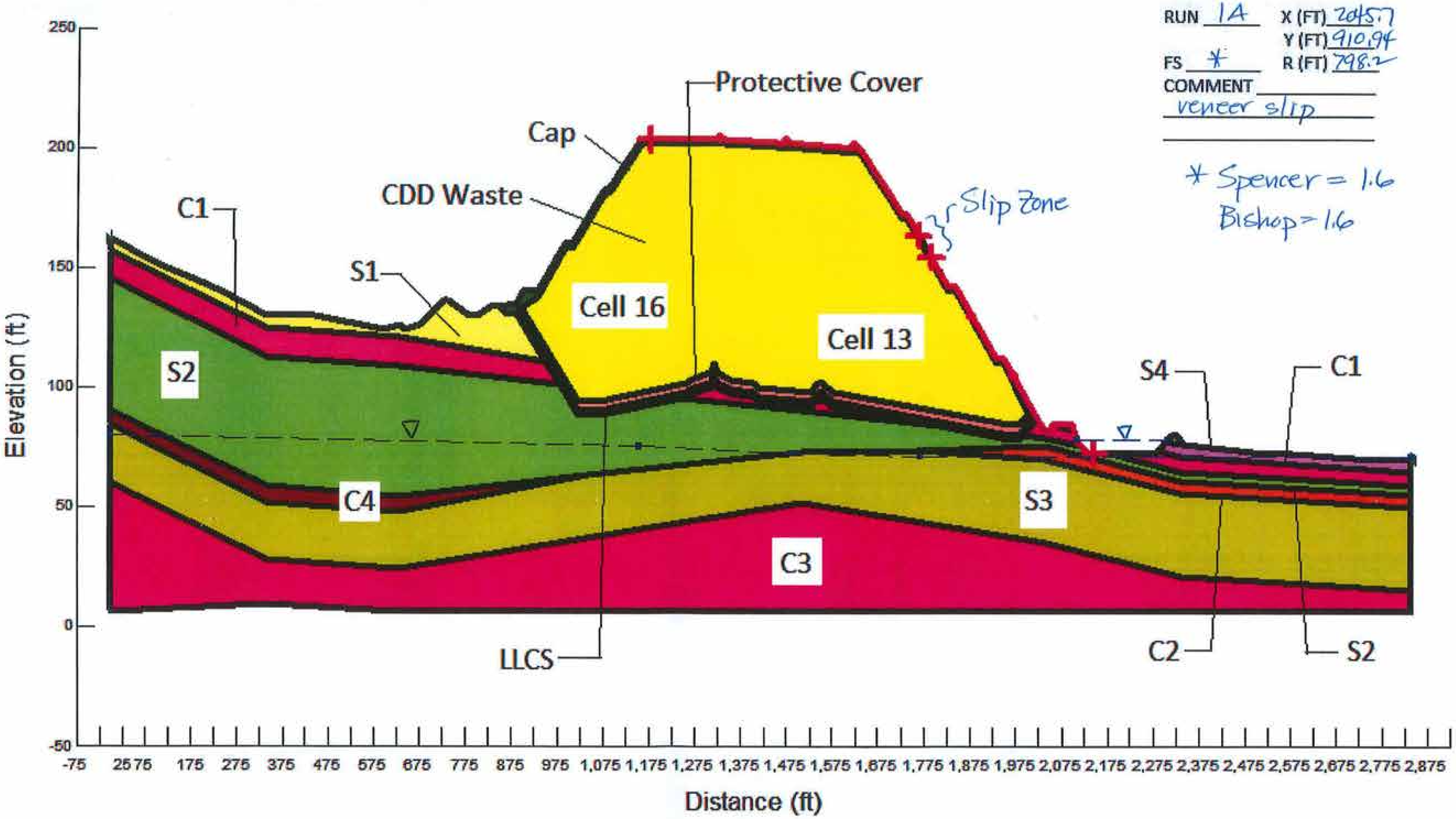


FIGURE 13.17 Limit Equilibrium Forces Involved in Pseudostatic Analysis Using a Average Seismic Coefficient.

Chesapeake Terrace Landfill, Slope Stability Analysis, Circular Slip Surface
Run 1A: Cell 16 through Cell 13, Static



RUN 1A X (FT) 2045.7
Y (FT) 910.94
FS * R (FT) 798.2
COMMENT
veneer slip

* Spencer = 1.6
Bishop = 1.6

GeoStudio/Slope W by Geo-Slope International, Ltd.

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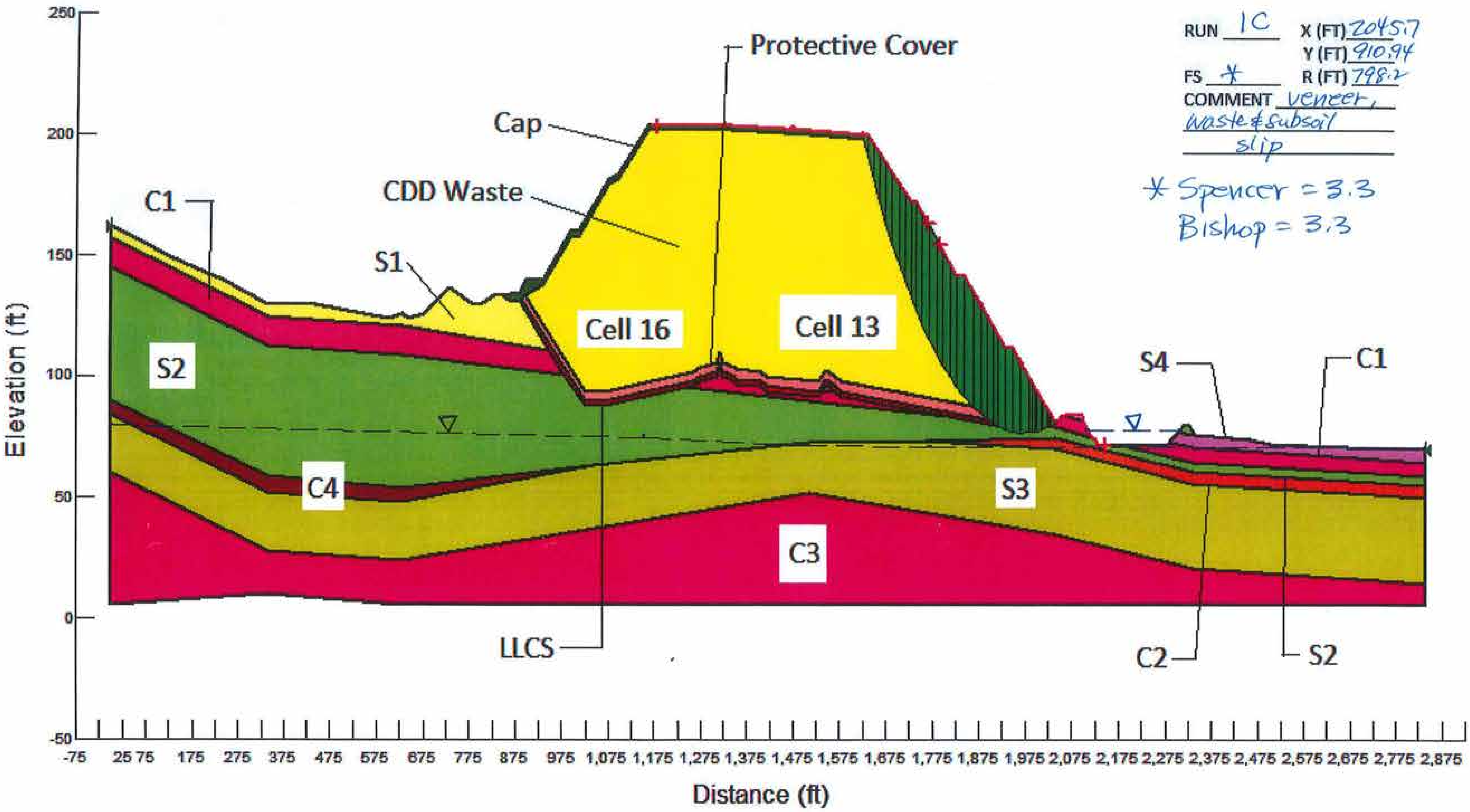
Chesapeake Terrace Landfill, Slope Stability Analysis, Circular Slip Surface
Run 1C: Cell 16 through Cell 13



RUN 1C
X (FT) 2045.7
Y (FT) 910.94
FS *
R (FT) 798.2
COMMENT veneer, waste & subsoil slip

* Spencer = 3.3
Bishop = 3.3

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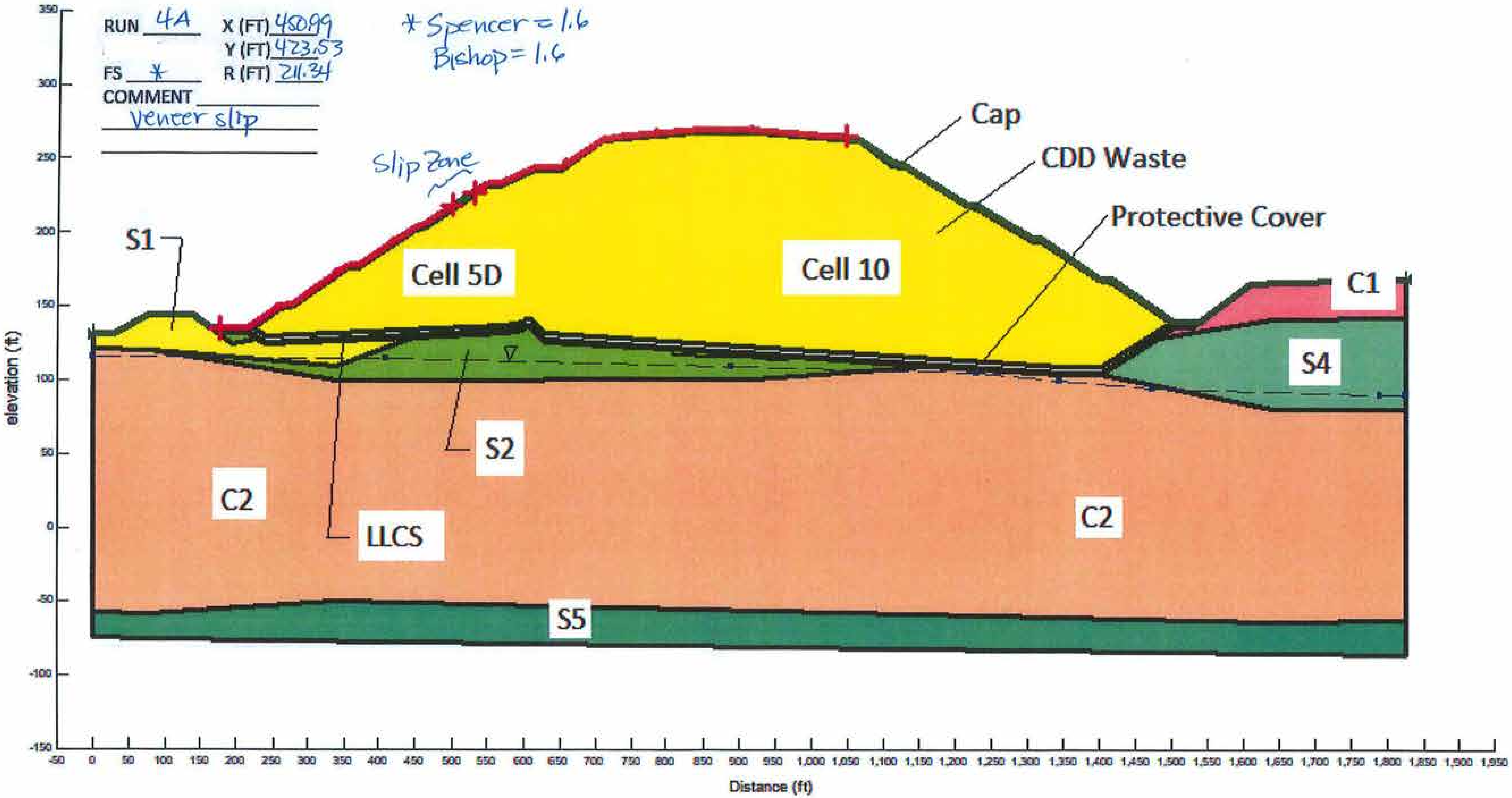
By ____ Date: 7/18/20 Chk: vy Date 7/19/20

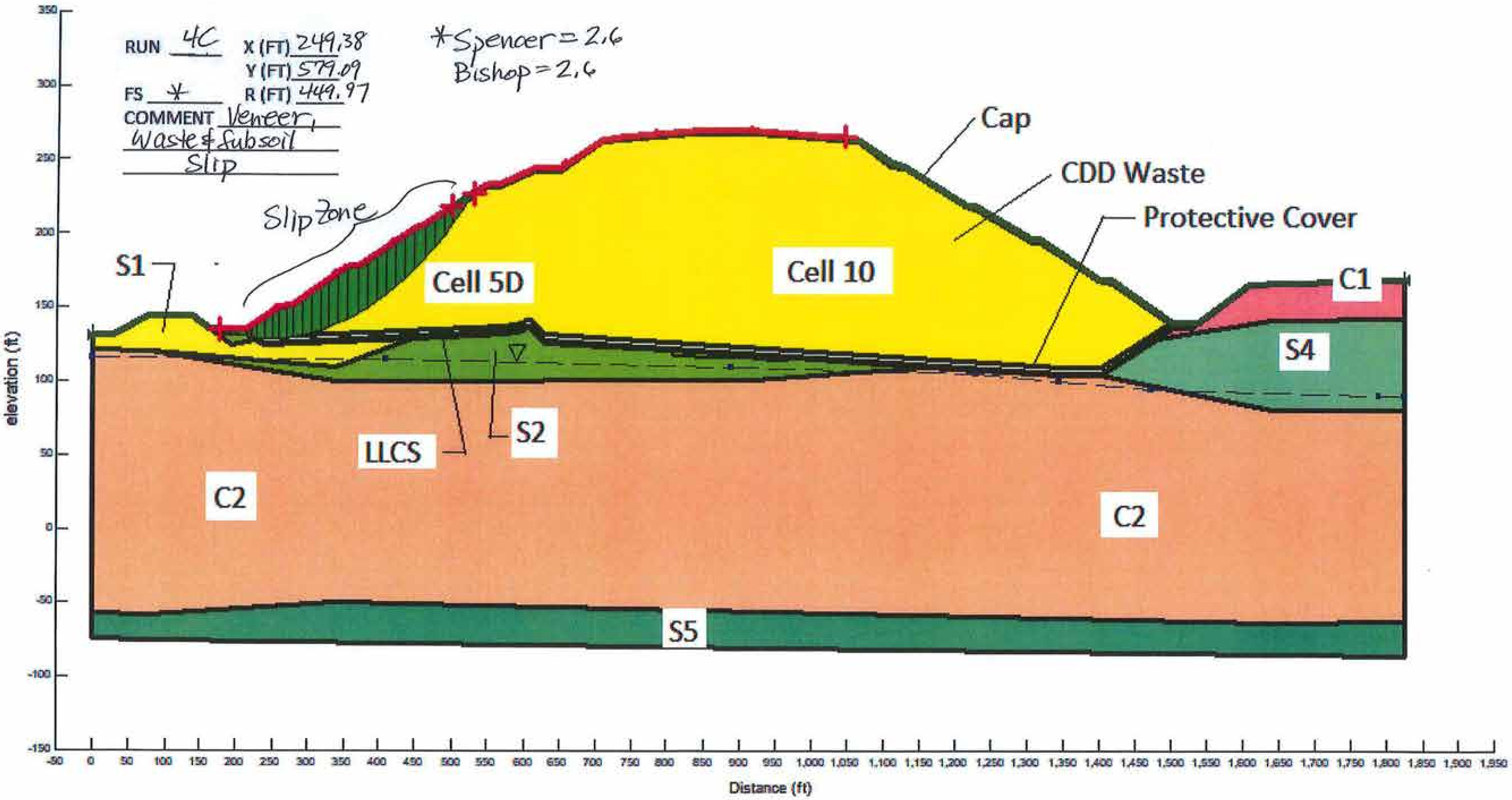
Chesapeake Terrace Landfill, Slope Stability Analysis, Circular Slip Surface
Run 4A: Cell 10 through Cell 5D, Static


RUN 4A
X (FT) 450.99
Y (FT) 423.53
FS *
R (FT) 211.34
COMMENT
veneer slip

* Spencer = 1.6
Bishop = 1.6

By Date: 7/18/20 Chk: Date 7/19/20

Chesapeake Terrace Landfill, Slope Stability Analysis, Circular Slip Surface
Run 4C: Cell 10 through Cell 5D, Static


RUN 4C X (FT) 249.38
Y (FT) 579.09
FS * R (FT) 449.97
COMMENT Veneer, Waste & Subsoil Slip

*Spencer = 2.6
Bishop = 2.6

GeoStudio/Slope W by Geo-Slope International, Ltd.

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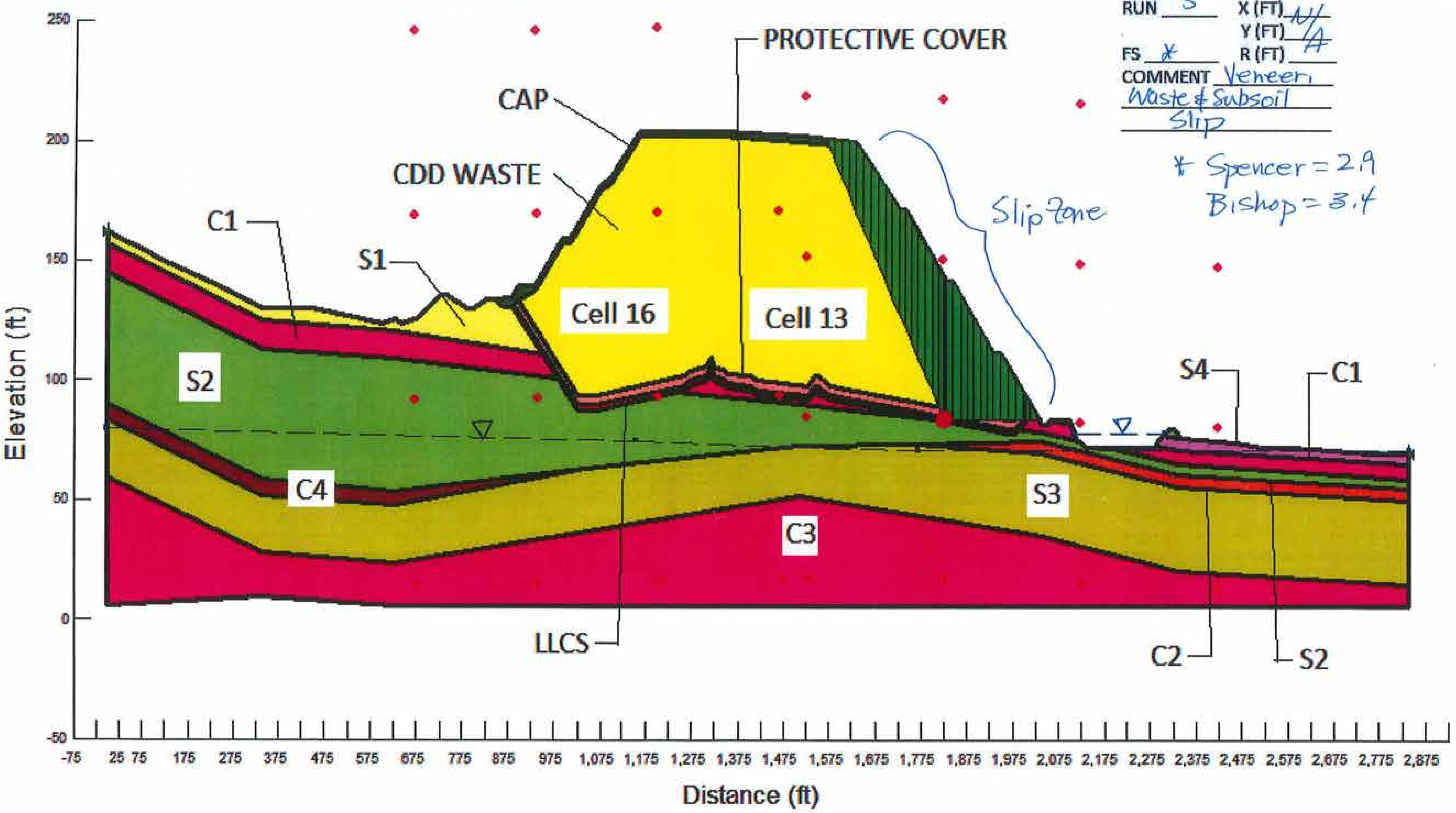
By Date: 7/18/20 Chk: Date 7/19/20

Chesapeake Terrace Landfill, Slope Stability Analysis, Non-Circular Slip Surface
Run 5: Cell 16 through Cell 13, Static

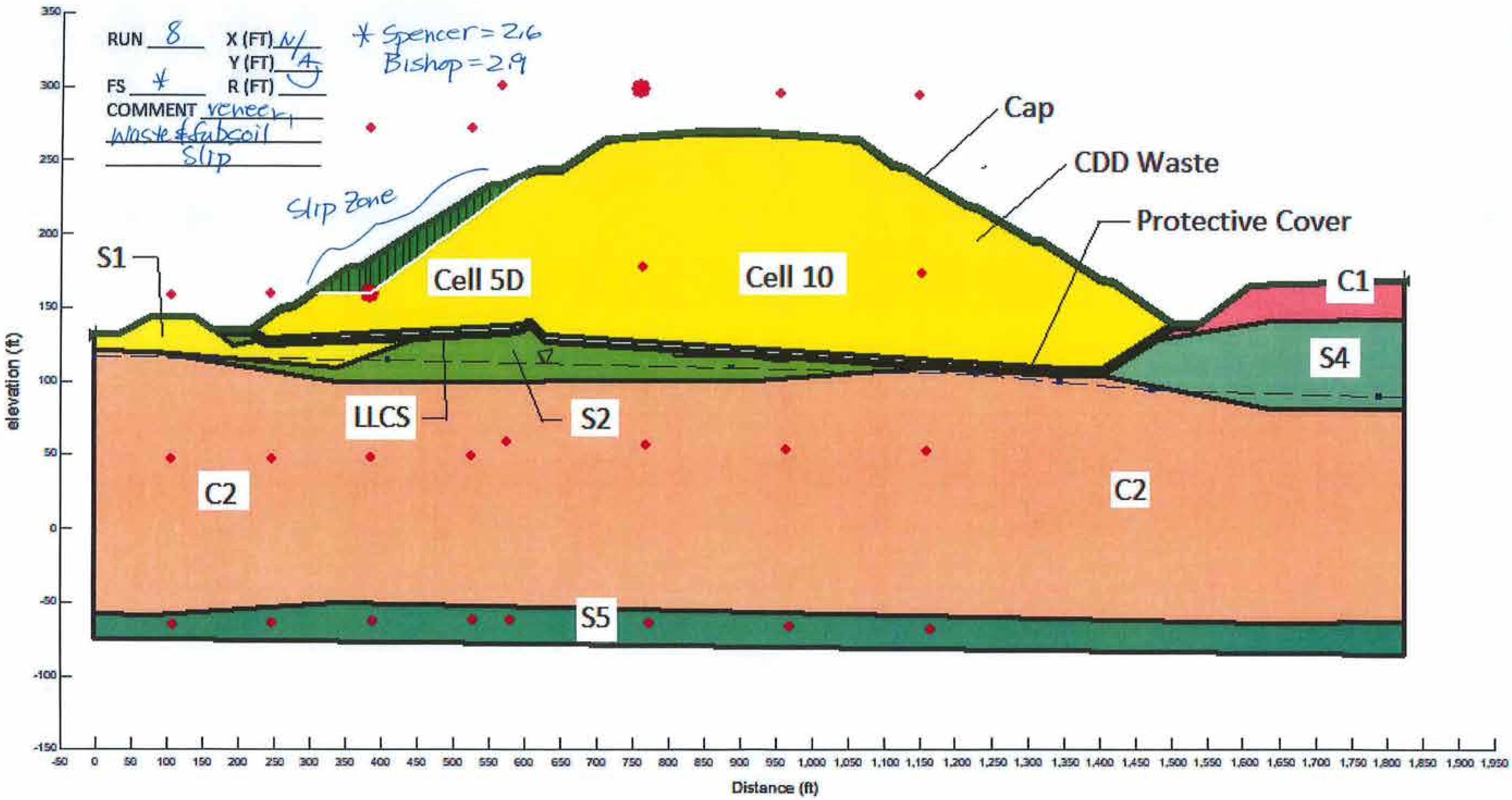


RUN 5 X (FT) N/A
Y (FT)
FS * R (FT)
COMMENT Veneer, Waste & Subsoil Slip

* Spencer = 2.9
Bishop = 3.4

GeoStudio/Slope W by Geo-Slope International, Ltd. PN 2018-3854 By Date: 7/18/20 Chk: Date 7/19/20

Chesapeake Terrace Landfill, Slope Stability Analysis, Non-Circular Slip Surface
Run 8: Cell 10 through Cell 5D, Static


RUN 8
X (FT) N/A
Y (FT)
R (FT)
FS *
COMMENT veneer, waste & subsoil slip

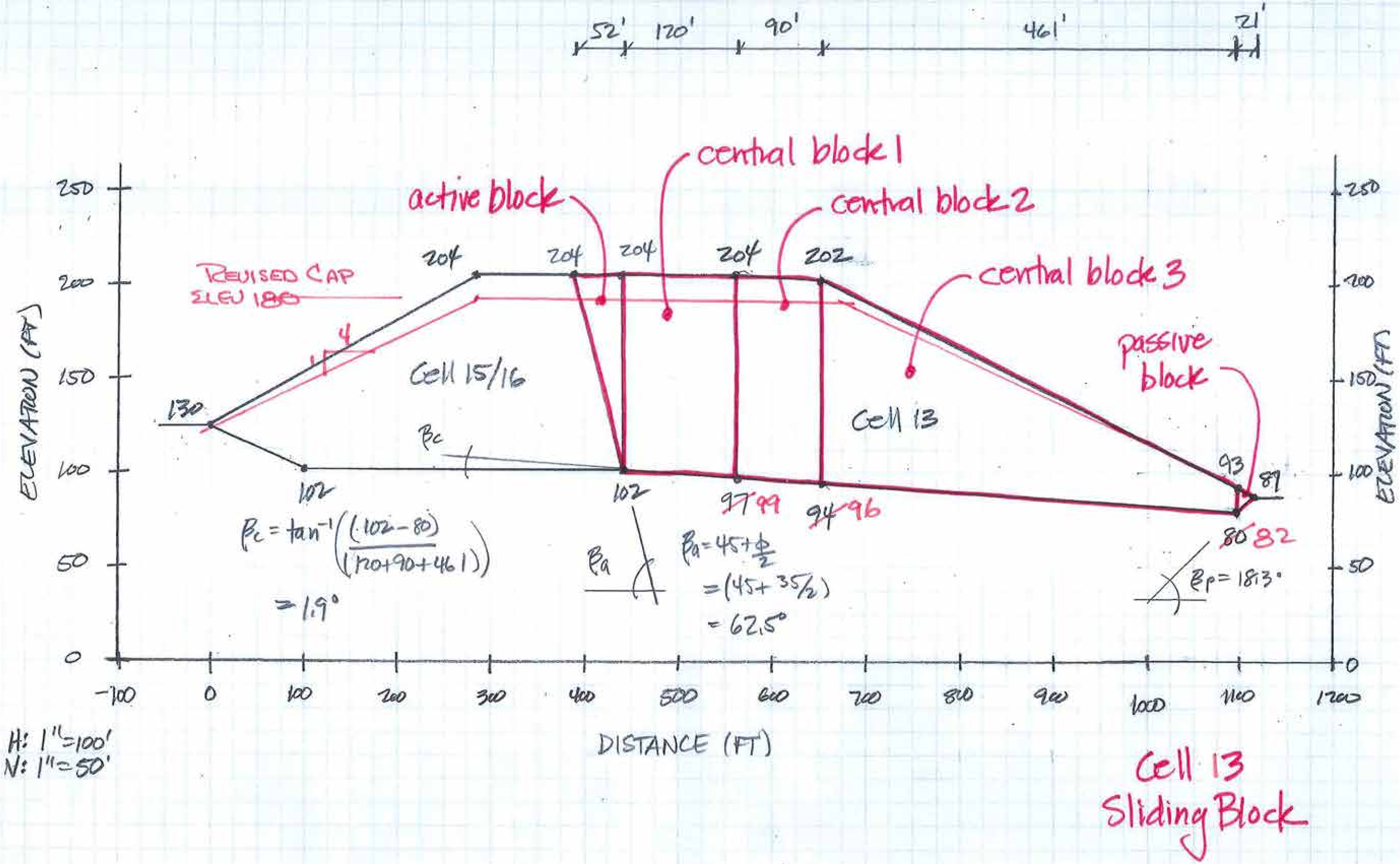
* Spencer = 2.6
Bishop = 2.9

GeoStudio/Slope W by Geo-Slope International, Ltd.

PN 2018-3854

By JA Date: 7/18/20 Chk: JLY Date 7/19/20

APPROXIMATE SECTION



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assume unit 1' slice

Active Block

$a = 0 \quad b = (\overset{180}{\cancel{204}} - 102) \quad h = 52'$

$= \cancel{102'}\ 78$

$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{0+\overset{78}{\cancel{102}}}{2}\right)(52) = \overset{2,028}{\cancel{2652}}\ \text{sf}$

$W_A = \gamma A = \frac{(48.7)(\overset{2028}{\cancel{2652}})}{1000} = \overset{99}{\cancel{129}}\ \text{K}$

$\gamma = 48.7\ \text{pcf}$ ✓

$\phi = 35°$ ✓

$P_A = \frac{\gamma H^2}{2}\left(\tan^2\left(45 - \frac{\phi}{2}\right)\right) = \frac{\overset{✓}{(48.7)}\overset{(78)^2}{(102)}^2}{(2)(1000)}\left(\tan^2\left(45 - \frac{35}{2}\right)\right)$

$= \frac{(48.7)(\overset{78^2}{\cancel{102}})^2}{2(1000)}\left(\tan^2(27.5)\right) = \overset{40}{\cancel{69}}\ \text{K}$

Central Block 1

$a = (\overset{180}{\cancel{304}} - 102) \quad b = (\overset{180 - 99}{\cancel{204} - 97}) \quad h = 120'$

$= \cancel{102'}\ 78 \qquad = \cancel{107'}\ 81$

$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{\overset{78+81}{\cancel{102}+107}}{2}\right)(120) = \overset{9540}{\cancel{12,540}}\ \text{sf}$

$W = \gamma A = \frac{(48.7)(\overset{9540}{\cancel{12,540}})}{1000} = \overset{465}{\cancel{611}}\ \text{K}$

SHEET 1 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Tew

BY JKA DATE 7/19/20 DESCRIPTION Cell 13 Sliding Block

CHK. BY PGS DATE 9/2/21

Central Block 2

$a = (\overset{180}{\cancel{204}} - \overset{99}{\cancel{97}}) \quad b = (\overset{180}{\cancel{202}} - \overset{96}{\cancel{94}}) \quad h = 90'$

$= \cancel{107}' \; 81' \qquad = \cancel{108}' \; 84$

$\text{Area } A = \frac{(a+b)}{2}(h) = \frac{(\overset{81}{\cancel{107}} + \overset{84}{\cancel{108}})}{2}(90) = \overset{7425}{\cancel{9675}} \text{ sf}$

$W = \gamma A = \frac{(48.7)(\overset{7425}{\cancel{9675}})}{1000} = \overset{362}{\cancel{471}} \text{ K}$

Central Block 3

$a = (\overset{180}{\cancel{202}} - \overset{96}{\cancel{94}}) \quad b = (93 - \overset{82}{\cancel{80}}) \quad h = 461'$

$= \cancel{108}' \; 84 \qquad = \cancel{13}' \; 11$

$\text{Area } A = \frac{(a+b)}{2}(h) = \frac{(\overset{84}{\cancel{108}} + \overset{11}{\cancel{13}})}{2}(461) = \overset{21{,}898}{\cancel{27{,}890}} \text{ sf}$

$W = \gamma A = \frac{(48.7)(\overset{21{,}898}{\cancel{27{,}890}})}{1000} = \overset{1{,}066}{\cancel{1358}} \text{ K}$

$W_c = (\overset{465}{611} + \overset{362}{\cancel{471}} + \overset{1066}{\cancel{1358}}) = \overset{1893}{\cancel{2440}} \text{ K}$

Passive Block

$a = (93 - \overset{82}{\cancel{80}}) = \overset{11}{\cancel{7}}' \quad b = 0' \quad h = 21'$

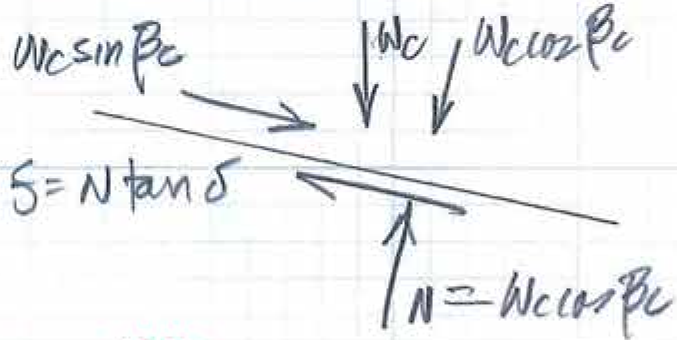
$\text{Area } A = \frac{(a+b)}{2}(h) = \frac{(\overset{11}{\cancel{7}} + 0)}{2}(21) = \overset{115}{\cancel{73}} \text{ sf}$

$W_p = \gamma A = \frac{(48.7)(\overset{115}{\cancel{73}})}{1000} = \overset{5.}{\cancel{3}} \text{ K}$

SHEET 2 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Chez Ten
BY JSA DATE 7/19/20 DESCRIPTION Cell 13 Sliding Block
CHK. BY PGS DATE 9/2/21

Central Block Forces

$\beta_c = 1.9°$
$\delta = 23°$
$W_c = 2440^K$



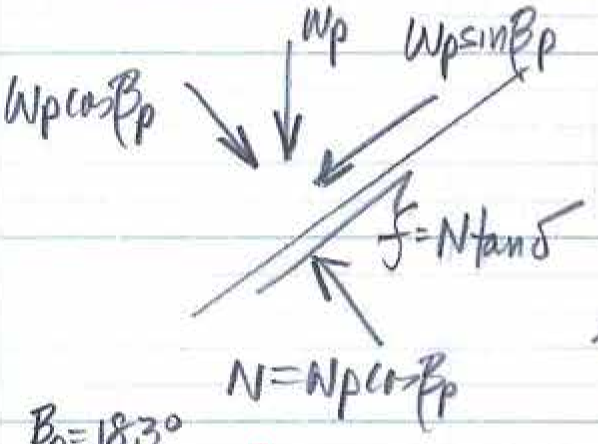
$W_c \sin\beta_c = (\overset{1893}{\cancel{2440}})(\sin 1.9) = \cancel{81}\ K\ 63K$

$W_c \cos\beta_c = (\overset{1893}{\cancel{2440}})(\cos 1.9) = \cancel{2439}\ K = N = 1892^K$

$f = N\tan\delta = (\overset{1892}{\cancel{2439}})(\tan \overset{18}{\cancel{23}}) = \overset{615}{\cancel{1035}}\ K$

$\searrow x \sum_1^i F = W_c \sin\beta_c - f = \overset{63}{\cancel{81}} - \overset{615}{\cancel{1035}} = -\overset{-552}{\cancel{954}}\ K = P_c$

Passive Block Forces



$W_p \sin\beta_p = (\overset{5}{\cancel{3}})(\sin 18.3) = \overset{2}{\cancel{1}}\ K$

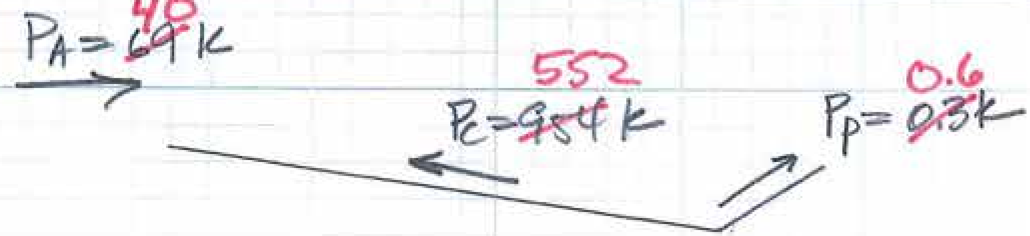
$W_p \cos\beta_p = (\overset{5}{\cancel{3}})(\cos 18.3) = \overset{5}{\cancel{3}}\ K = N$

$f = (\overset{5}{\cancel{3}})(\tan \overset{18}{\cancel{23}}) = \overset{1.6}{\cancel{1.3}}\ K$

$\nearrow x \sum_1^i F = f - W_p \sin\beta_p$

$= \underset{1.6}{\cancel{1.3}} - 1 = \underset{0.6}{0.3}\ K = P_p$

$\beta_p = 18.3°$
$\delta = \cancel{23°}\ 18°$
$W_p = \cancel{3K}\ 5^K$



Resolve Forces in the Horizontal Direction

$P_{c_h} = P_c \cos\beta_c = (\overset{552}{\cancel{954}})(\cos 1.9) = \cancel{953\,K}\ 552\ K$

$P_{p_h} = P_p \cos\beta_p = (\overset{0.6}{\cancel{0.3}})(\cos 1.9) = \cancel{0.3\,K}\ 0.6$

Σ_i' Driving forces $= P_A + P_{p_h} = (\overset{40+0.6}{\cancel{69}+0.3}) = \cancel{69}\,K$ 41 K

Σ_i' Resisting forces $= P_{c_h} = \overset{552}{\cancel{954}}\,K$

$FS = \dfrac{\Sigma_i' \text{ Resisting Forces}}{\Sigma_i' \text{ Driving Forces}} = \dfrac{\overset{552}{\cancel{954}}}{\cancel{69}\ 40} = 13.8$ ✓

Add Seismic Influence

$a = 0.065$
$C_s = \frac{a}{2} = 0.0325$
$K_h = 0.0325$

$P_A' = K_h(W_A) = (0.0325)(\overset{99}{\cancel{129}}) = \overset{3\,K}{\cancel{4\,K}}$

$P_{ch}' = K_h(W_c) = (0.0325)(\overset{1893}{\cancel{2440}}) = \overset{62}{\cancel{79}}\,K$

$P_{ph}' = K_h(W_p) = (0.0325)(\overset{5}{\cancel{3}}) = \overset{0.2}{\cancel{0.1}}\,K$

* The added seismic forces act towards <u>downslope</u>. *

SHEET 4 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Che Ten
BY JKA PGS DATE 7/19/20 DESCRIPTION Cell 13 Sliding Block
CHK. BY PGS DATE 9/2/21

$$\Sigma'_1 \text{ Driving Forces} = (P_A + P_A') + P_{ch}' + P_{ph}$$

$$= (\overset{40}{\cancel{69}} + \overset{3}{\cancel{14}}) + \overset{62}{\cancel{79}} + \overset{0.6}{\cancel{0.3}} = \cancel{152}\ K \ \underline{106\ K}$$

$$\Sigma'_1 \text{ Resisting Forces} = P_{ch} + P_{ph}' = \cancel{953} + 0.1 = 953K$$

$$FS = \frac{\Sigma'_1 \text{ Resisting Forces}}{\Sigma'_1 \text{ Driving Forces}} = \frac{\overset{552}{953}}{\underset{106}{\cancel{152}}} = \cancel{6.3}\ 5.2$$

SHEET 5 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Ten

BY JKA DATE 7/19/20 DESCRIPTION Cell 13 Sliding Block

CHK. BY AGS DATE 9/2/21

ADVANCED GeoServices

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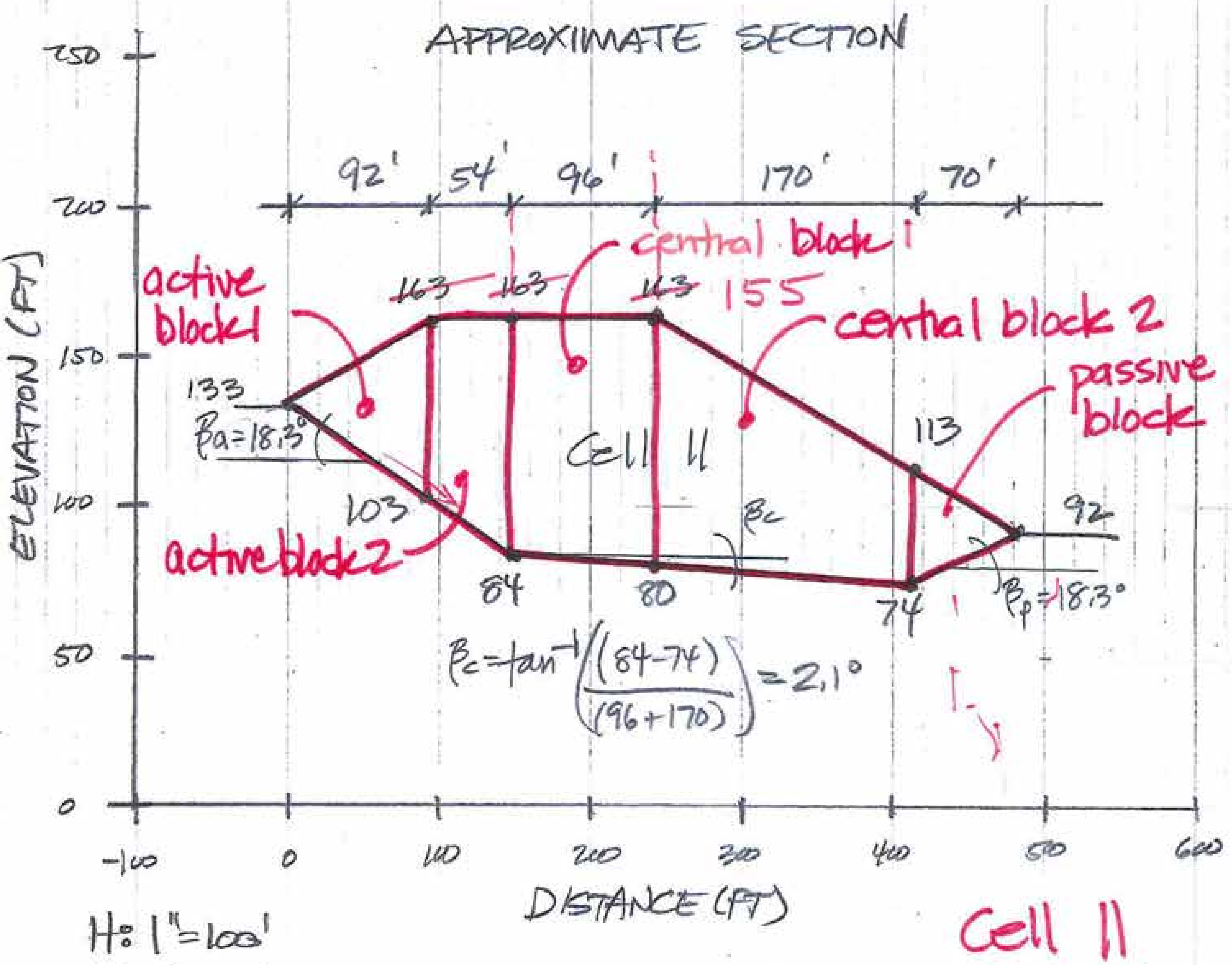

$\beta_c = \tan^{-1}\left(\frac{(84-74)}{(96+170)}\right) = 2{,}1°$

H: 1" = 100'

V: 1" = 50'

Cell 11

Sliding Block

SHEET 1 OF 1 PROJECT NO. 2018-3854 PROJECT NAME Chas TEW

BY JCA DATE 7/19/20 DESCRIPTION Cell 11 Sliding Block

CHK. BY PGS DATE 9/2/21

ADVANCED GeoServices

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assume unit 1' slice

Active Block 1

a=0 b=(~~163~~ 155 −103) h=92'

=~~60~~ 52

Area A = $\frac{(a+b)}{2}$ (h) = $\frac{(0+60)}{2}$ (92) = ~~2760~~ 2392 sf

W = γA = $\frac{(48.7)(\text{~~2760~~ } 2392)}{1000}$ = ~~134~~ 116 K

Active Block 2

a = (~~163~~ 155 −103) b=(~~163~~ 155 −84) h=54'

= ~~60'~~ 52 = ~~79'~~ 71

Area A = $\frac{(a+b)}{2}$ (h) = ($\frac{\text{~~60~~ } 52 + \text{~~79~~ } 71}{2}$)(54) = ~~3755~~ 3321 sf

W = γA = $\frac{(48.7)(\text{~~3753~~ } 3,321)}{1000}$ = ~~183~~ 162 K

W_A = (~~183~~ 162 + 134 116) = ~~317~~ 278 K

Central Block 1

a = (~~163~~ 155 −84) = ~~79'~~ 71 b= (~~163~~ 155 −80) = ~~83~~ 75 h=96'

Area A = $\frac{(a+b)}{2}$ (h) = ($\frac{\text{~~79+83~~ } 71+75}{2}$)(96) = ~~7776~~ 7008 sf

W = γA = $\frac{(48.7)(\text{~~7776~~ } 7008)}{1000}$ = ~~379~~ 341 K

SHEET 1 OF 5 PROJECT NO. 2018-3854 PROJECT NAME ChesTex
BY KA DATE 7/19/20 DESCRIPTION Cell 11 Sliding Block
CHK. BY PGS DATE 9/1/21

Central Block 2

$a = (\overset{155}{\cancel{163}} - 80) = \overset{75'}{\cancel{83}}'$ $b = (113-74) = 39'$ ✓ $h = 170'$

$\text{Area } A = \frac{(a+b)}{2}(h) = \frac{(\overset{75}{\cancel{83}} + 39)}{2}(\overset{170}{\cancel{170}})$ ✓ $= \overset{9.690}{\cancel{10,370}}$ sf

$$W = \gamma A = \frac{(48.7)(\overset{9690}{\cancel{10,370}})}{1000} = \overset{472}{\cancel{505}}\text{ K}$$

$$W_c = (\overset{341}{\cancel{379}} + \overset{472}{\cancel{505}}) = \overset{813}{\cancel{884}}\text{ K}$$

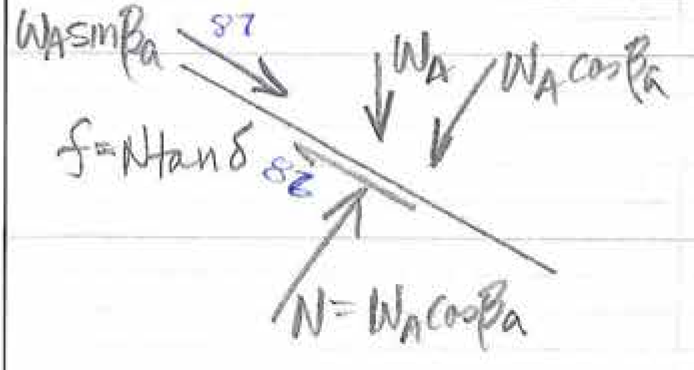
Passive Block

$a = (113-74) = 39'$ ✓ $b = 0$ $h = 70'$ ✓

$\text{Area } A = \frac{(a+b)}{2}(h) = \frac{(39+0)}{2}(70) = 1365$ sf ✓

$$W_p = \gamma A = \frac{(48.7)(1365)}{1000} = 66\text{ K}$$ ✓

Active Block Forces



$\beta_a = 18.3°$

$\delta = \cancel{23°}$ 18°

$W_A = \underset{278}{\cancel{317}}$ K

SHEET 2 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Che Terr
BY VJA DATE 7/19/20 DESCRIPTION Cell 11 Sliding Block
CHK. BY PGS DATE 9/2/21

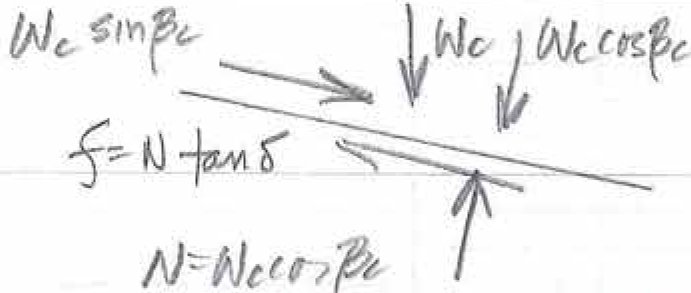
$W_A \sin\beta_a = (\overset{278}{\cancel{317}})(\sin 18.3) = \cancel{99}K\ 87^K$

$W_A \cos\beta_a = (\overset{278}{\cancel{317}})(\cos 18.3) = \overset{264}{\cancel{301}}K = N$

$f = N\tan\delta = (\overset{264}{\cancel{301}})(\tan \overset{18}{\cancel{23}}) = \cancel{13K}\ 86^K$

$\searrow \sum_1 F = W_A\sin\beta_a - f = \overset{87}{\cancel{99}} - \overset{86}{\cancel{13}} = \overset{1}{\cancel{86}}K = P_A$

Central Block Forces



$\beta_c = 2.1°$

$\delta = \cancel{23°}\ 18°$

$W_c = \cancel{884}K$ 813

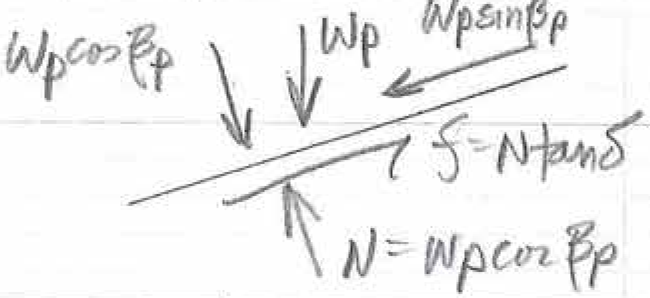
$W_c \sin\beta_c = (\overset{813}{\cancel{884}})(\sin 2.1) = \overset{30}{\cancel{32}}K$

$W_c \cos\beta_c = (\overset{813}{\cancel{884}})(\cos 2.1) = \cancel{883}\ 812^K = N$

$f = N\tan\delta = (\overset{812}{\cancel{883}})(\tan \overset{18}{\cancel{23}}) = \overset{264}{\cancel{375}}K$

$\searrow \sum_1 F = W_c\sin\beta_c - f = (\overset{30}{\cancel{32}} - \overset{264}{\cancel{375}}) = \overset{-234}{\cancel{-343}}K = P_c$

Passive Block Forces



$\beta_p = 18.3°$

$\delta = \cancel{23°}\ 18°$

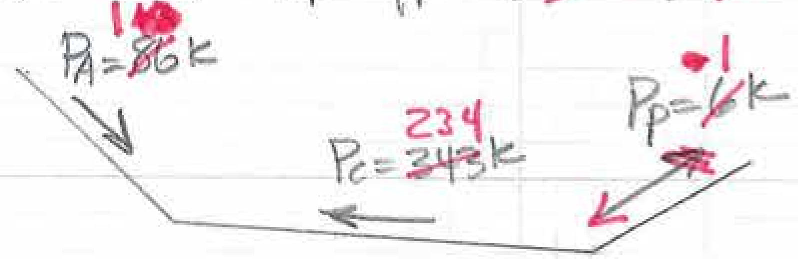
$W_p = 66K$ ✓

$W_p \sin\beta_p = (66)(\sin 18.3) = 21\,K$ ✓

$W_p \cos\beta_p = (66)(\cos 18.3) = 63\,K = N$ ✓

$f = N \tan\delta = (63)(\tan \overset{18}{\cancel{23}}) = 20\,K = P_p$

$x \nearrow \sum_1 F = f - W_p \sin\beta_p = (\overset{20-21}{\cancel{27-21}}) = \overset{-1}{\cancel{6}}\,K$



Resolve Forces in the Horizontal Direction

$P_{Ah} = P_A \cos\beta_a = (\overset{1\text{[illegible]}}{\cancel{86}})(\cos 18.3) = \overset{1\text{[illegible]}}{\cancel{82}}\,K$

$P_{ch} = P_c \cos\beta_c = (\overset{234}{\cancel{343}})(\cos 2.1) = \overset{234}{\cancel{342.8}}\,K$

$P_{ph} = P_p \cos\beta_p = (\overset{1}{\cancel{6}})(\cos 18.3) = \cancel{5.7}\ 1$

$\sum_1 \text{Driving Forces} = P_{Ah} + P_{ph} = \overset{1\text{[illegible]}}{\cancel{82}} + \overset{1}{\cancel{5.7}} = \overset{\text{[illegible]}2}{\cancel{87.7}}$

$\sum_1 \text{Resisting Forces} = P_{ch} = \overset{235}{\cancel{342.8}}\,K$

$$FS = \frac{\sum_1 \text{Resisting Forces}}{\sum_1 \text{Driving Forces}} = \frac{\overset{235}{\cancel{342.8}}}{\underset{\text{[illegible]}2}{\cancel{87.7}}} = \underset{19.6}{\cancel{3.9}}$$

SHEET 4 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Chn Tew
BY JCA DATE 7/19/20 DESCRIPTION Cell 11 Sliding Block
CHK. BY PGS DATE 9/2/21

Add Seismic Influence

$a = 0.065$
$C_s = \frac{a}{2} = 0.0325$
$K_h = 0.0325$

$P_{Ah}' = K_h(W_A) = (0.0325)(\overset{278}{\cancel{317}})$
$= \cancel{10\ K}\ 9^K$

$P_{ch}' = K_h(W_c) = (0.0325)(\overset{813}{\cancel{884}}) = \overset{26}{\cancel{29}}\ K$

$P_{Ph}' = K_h(W_p) = (0.0325)(66) = 2\ K$ ✓

* The added Seismic forces act towards downslope *

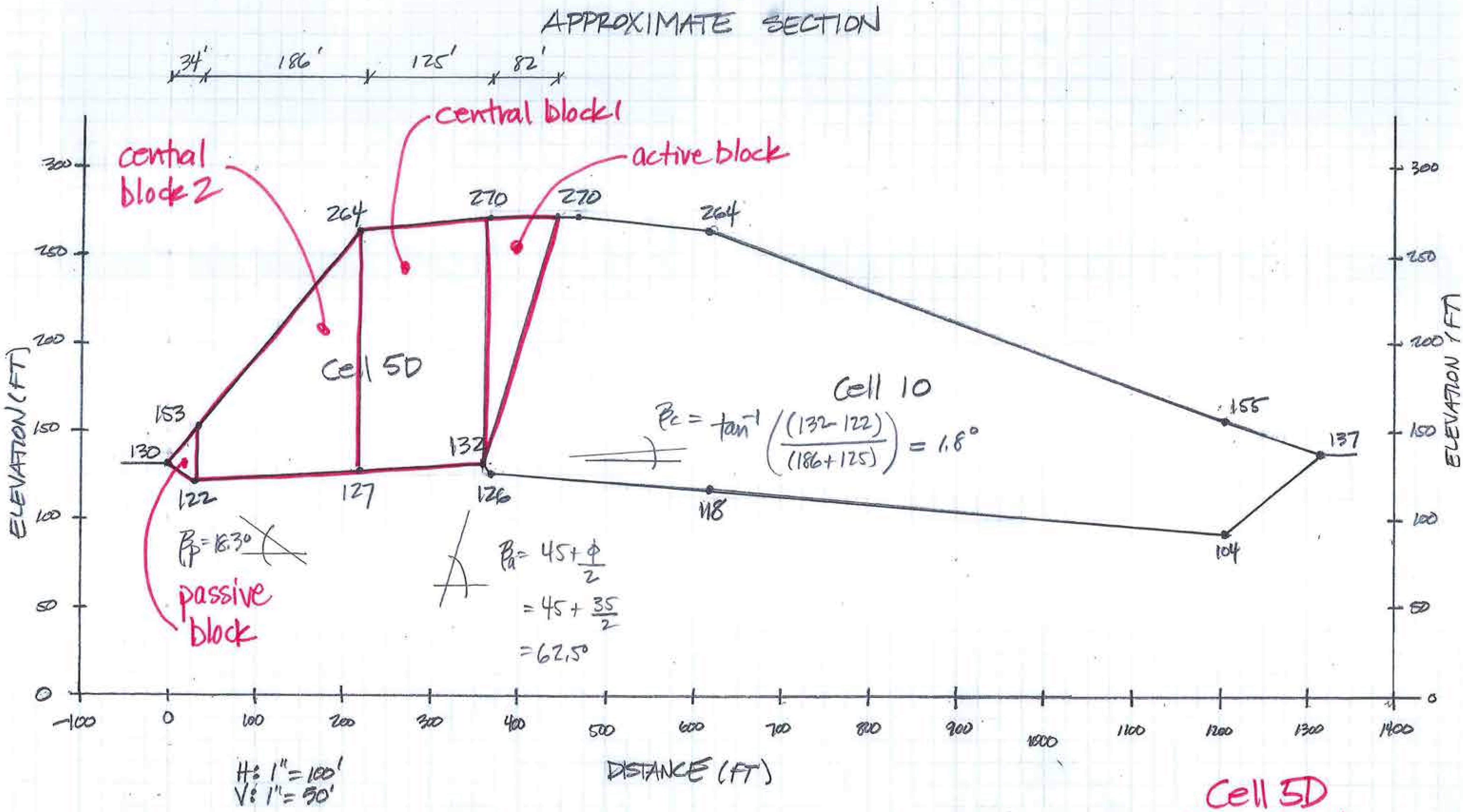
Σ' Driving Forces $= (P_{Ah} + P_{Ah}') + P_{ch}' + P_{ph}$
$= (\overset{12}{\cancel{82}} + \overset{9}{10}) + \overset{26}{\cancel{29}} + \overset{1}{5.7} = \overset{48}{\cancel{209}}\ K$

Σ' Resisting Forces $= P_{ch} + P_{Ph}'$
$= 342.8 + 2 = 344.8\ K$

$$FS = \frac{\Sigma' \text{ Resisting Forces}}{\Sigma' \text{ Driving Forces}} = \frac{344.8}{\underset{48}{\cancel{209}}} = \underset{7.1}{\cancel{1.6}}$$

2018 -

SHEET 5 OF 5 PROJECT NO. 3854 PROJECT NAME [illegible]
BY JGA DATE 7/19/20 DESCRIPTION Cell 11 Sliding Block
CHK. BY PGS DATE 9/2/21



$\beta_p = 18.3°$

$\beta_a = 45 + \frac{\phi}{2}$

$= 45 + \frac{35}{2}$

$= 62.5°$

$\beta_c = \tan^{-1}\left(\frac{(132-122)}{(186+125)}\right) = 1.8°$

Cell 5D Sliding Block

Active Block

*assume unit 1' slice *

$\gamma = 48.7$ pcf

$a = 0$ $b = (270 - 132) = 138'$ $h = 82'$ $\phi = 35°$

$$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{0+138}{2}\right)(82) = 5658 \text{ sf}$$

$$W_A = \gamma A = \frac{(48.7)(5658)}{1000} = 275 \text{ K}$$

$$P_A = \frac{\gamma H^2}{2}\left(\tan^2\left(45 - \frac{\phi}{2}\right)\right) = \frac{(48.7)(138)^2}{2(1000)}\left(\tan\left(45 - \frac{35}{2}\right)\right)$$

$$= \frac{(48.7)(138)^2}{2(1000)}\left(\tan^2\left(45 - \frac{35}{2}\right)\right) = 126 \text{ K}$$

Central Block 1

$a = (270 - 132) = 138'$ $b = (264 - 127) = 137'$ $h = 125'$

$$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{138+137}{2}\right)(125) = 17,187 \text{ sf}$$

$$W = \gamma A = \frac{(48.7)(17,187)}{1000} = 837 \text{ K}$$

RUN WITHOUT
RECALCULATING
LOWER ELEVATIONS
(MORE CONSERVATIVE)

SHEET 1 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Terr
BY JCA DATE 7/19/20 DESCRIPTION Cell 5D Sliding Block
CHK. BY PGS DATE 9/2/21

Central Block 2

$a = (264 - 127) = 137$ $\quad b = (153 - 122) = 31$ $\quad h = 186'$

$$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{137+31}{2}\right)(186) = 15{,}624 \text{ sf}$$

$$W = \gamma A = \frac{(48.7)(15{,}624)}{1000} = 761 \text{ K}$$

$$W_C = (837 + 761) = 1598 \text{ K}$$

Passive Block

$a = (153 - 122) = 31'$ $\quad b = 0$ $\quad h = 34'$

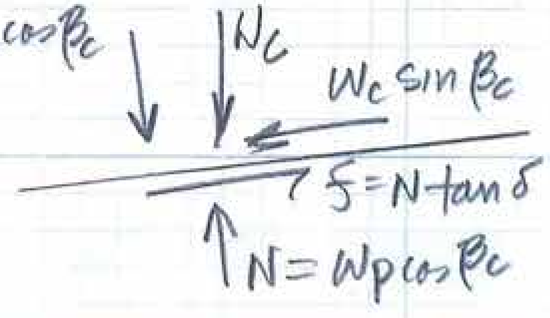
$$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{31+0}{2}\right)(34) = 527 \text{ sf}$$

$$W_P = \gamma A = \frac{(48.7)(527)}{1000} = 26 \text{ K}$$

SHEET 2 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Terr
BY JCA DATE 7/19/20 DESCRIPTION Cell 5D Sliding Block
CHK. BY PGS DATE 9/2/21

Central Blocks Forces

$\beta_c = 1.8°$
$\delta = \cancel{23°}\ 18°$
$W_c = 1598\ K$



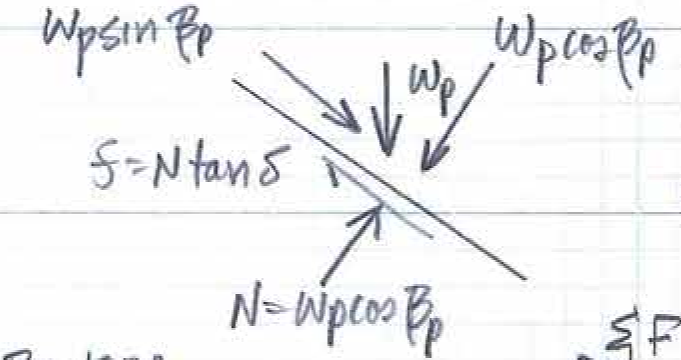
$W_c \sin\beta_c = (1598)(\sin 1.8) = 50\ K$

$W_c \cos\beta_c = (1598)(\cos 1.8) = 1597 K = N$

$f = N\tan\delta = (1597)(\tan \cancel{23}) = \cancel{678 K}\ 519^{K}$
$ 18$

$\swarrow^{+} \sum F = W_c\sin\beta_c - f = 50 - \cancel{678} \overset{519}{} = -\cancel{628}\overset{-469}{}\ K = P_c$

Passive Block Forces



$W_p\sin\beta_p = (26)(\sin 18.3) = 8 K$

$W_p\cos\beta_p = (26)(\cos 18.3) = 25 K = N$

$f = N\tan\delta = (25)(\tan\cancel{23})$ 18
$= \cancel{11}\ 8 K$

$\nwarrow^{+} \sum F = f - W_p\sin\beta_p$
$= 11 - 8 = 3K = P_p$
$8 - 8 = 0$

$\beta_p = 18.3°$
$\delta = \cancel{23°}\ 18°$
$W_p = 26 K$

SHEET 3 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Tew
BY JCA DATE 7/19/20 DESCRIPTION Cell 5D Sliding Block
CHK. BY PGS DATE 9/2/21

ADVANCED GeoServices

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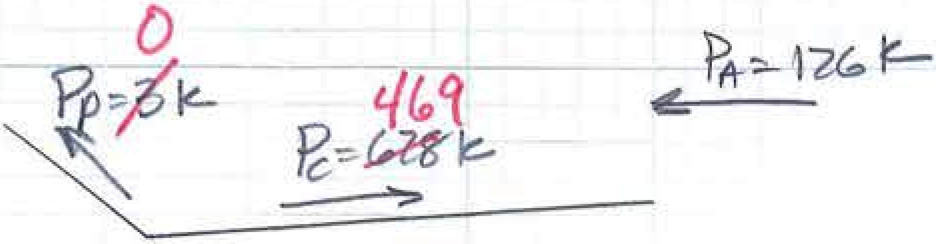


Resolve Forces in the Horizontal Direction

$P_{c_h} = P_c \cos\beta_c = (\overset{469}{\cancel{628}})(\cos 1.8) = \overset{468}{\cancel{625}}\,K$

$P_{p_h} = P_p \cos\beta_p = (\overset{0}{\cancel{3}})(\cos 18.3) = \overset{0}{\cancel{2.8}}\,K$

$\sum_i \text{Driving forces} = P_A + P_{p_h} = 126 + \overset{0}{\cancel{2.8}} = \overset{126^K}{\cancel{129}}\,K$

$\sum_i \text{Resisting forces} = P_{c_h} = \overset{469}{\cancel{628}}\,K$

$$FS = \frac{\sum_i \text{Resisting forces}}{\sum_i \text{Driving forces}} = \frac{469\,\cancel{675}}{126\,\cancel{129}} = \cancel{4.8}\ 3.7$$

Add Seismic Influence

$a = 0.065$

$C_S = \frac{a}{2} = 0.0325$

$K_h = 0.0325$

$P_A' = K_h(W_A) = (0.0325)(275)$
$= 9K$

$P_{c_h}' = K_h(W_C) = (0.0325)(1598) = 52\,K$

SHEET 4 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Tew
BY VCA DATE 7/19/20 DESCRIPTION Cell 5D Sliding Block
CHK. BY PGS 9/2/21 DATE

$$P'_{Ph} = K_h(W_p) = (0.0325)(26) = 1\ K$$

* the additional seismic forces act towards downslope. *

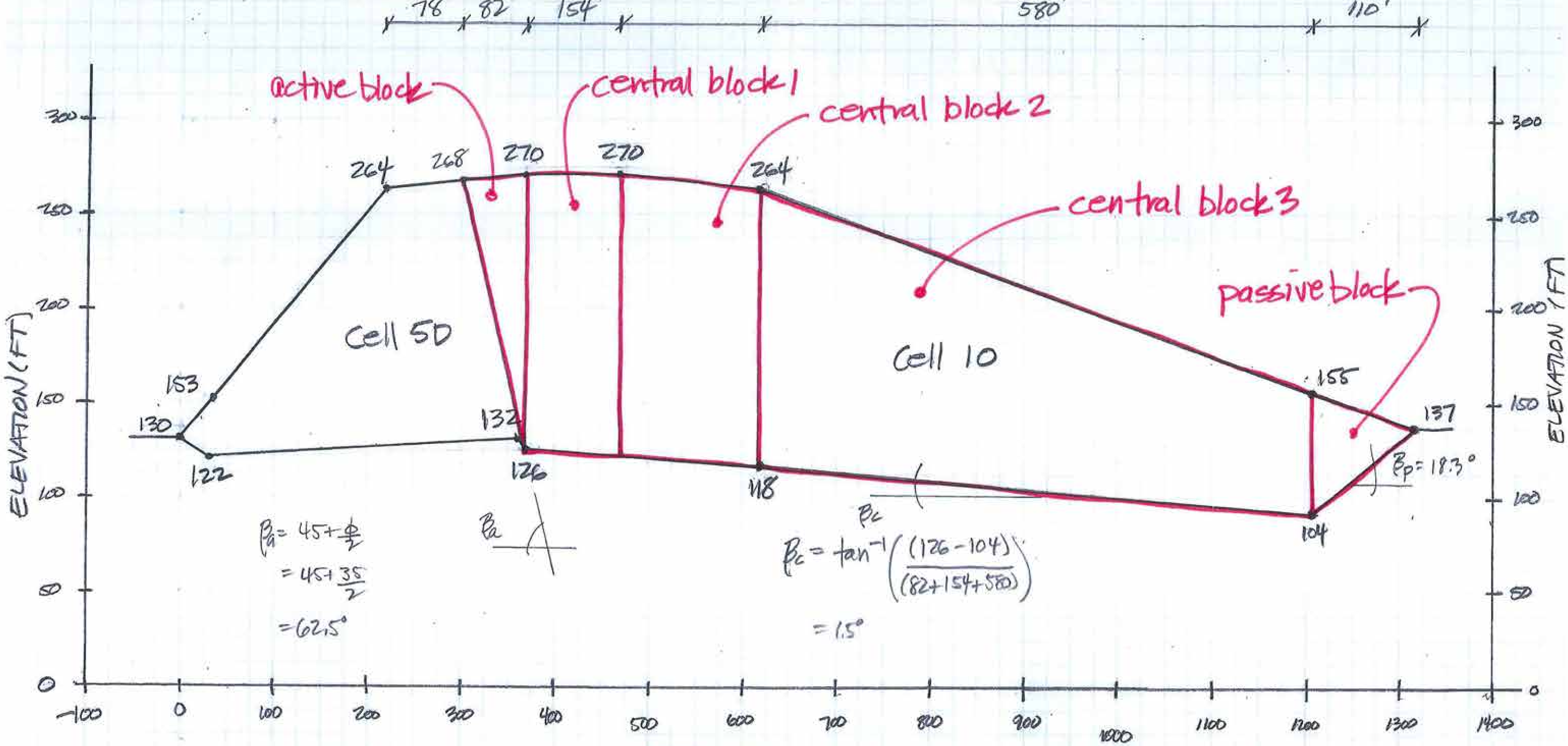
$$\Sigma_i' \text{ Driving forces} = (P_A + P_A') + P'_{Ch} + P_{Ph}$$
$$= (126 + 9) + 52 + \overset{0}{\cancel{3}} = \overset{187}{\cancel{190}}\ K$$

$$\Sigma_i' \text{ Resisting Forces} = \overset{469\,+\,1}{P_{Ch} + P'_{Ph}} = \overset{469}{\cancel{625}} + 1 = \overset{470}{\cancel{626}}\ K$$

$$FS = \frac{\Sigma_i' \text{ Resisting Forces}}{\Sigma_i' \text{ Driving Forces}} = \frac{\cancel{626}\ 470}{\cancel{190}\ 187} = \cancel{3.3}\ 2.5$$

SHEET 5 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Terr
BY JCA DATE 7/19/20 DESCRIPTION Cell 5D Sliding Block
CHK. BY PGS DATE 9/2/21

APPROXIMATE SECTION



$$\beta_a = 45 + \frac{\phi}{2}$$
$$= 45 + \frac{35}{2}$$
$$= 62.5°$$

$$\beta_c = \tan^{-1}\left(\frac{(126-104)}{(82+154+580)}\right)$$
$$= 1.5°$$

H: 1" = 100'
V: 1" = 50'

Cell 10
Sliding Block

Active Block

* assume unit 1' slice *

$a=0$ $b=(270-126)=144$ $h=78'$ $\gamma=48.7$ pcf $\phi=35°$

$$\text{Area } A=\left(\frac{a+b}{2}\right)(h)=\left(\frac{0+144}{2}\right)(78)=5616 \text{ sf}$$

$$W_A=\gamma A=\frac{(48.7)(5616)}{1000}=274 \text{ K}$$

$$P_A=\frac{\gamma H^2}{2}\left(\tan^2\left(45-\frac{\phi}{2}\right)\right)=\frac{(48.7)(144)^2}{(2)1000}\left(\tan^2\left(45-\frac{35}{2}\right)\right)$$

$$=\frac{(48.7)(144)^2}{(2)1000}(0.52)^2=137 \text{ K}$$

Central Block

$a=(270-126)=144'$ $b=(270-122)=148'$ $h=82'$

$$\text{Area } A=\left(\frac{a+b}{2}\right)(h)=\left(\frac{144+148}{2}\right)(82)=11{,}972 \text{ SF}$$

$$W=\gamma A=\frac{(48.7)(11{,}972)}{1000}=583 \text{ K}$$

- RERUN FOR LOWER δ BETWEEN HDPE-T AND SUBBASE. ASSUME CAP ELEVATIONS UNCHANGED

SHEET 1 OF 1 PROJECT NO. 2018-3054 PROJECT NAME Chester
BY JCA DATE 7/19/20 DESCRIPTION Cell 10 Sliding Block
CHK. BY DGS DATE 9/2/21

Central Block 2

$a = (270 - 122)$ $b = (264 - 118)$ $h = 154'$
$= 148'$ $= 146'$

$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{148+146}{2}\right)(154) = 22{,}638 \text{ sf}$

$W = \gamma A = \frac{(48.7)(22{,}638)}{1000} = 1102 \text{ K}$

Central Block 3

$a = (264 - 118)$ $b = (155 - 104)$ $h = 580'$
$= 146'$ $= 51'$

$\text{Area } A = \frac{(a+b)}{2}(h) = \left(\frac{146+51}{2}\right)(580) = 57{,}130 \text{ sf}$

$W = \gamma A = \frac{(48.7)(57{,}130)}{1000} = 2782 \text{ K}$

$W_c = (583 + 1102 + 2782) = 4467 \text{ K}$

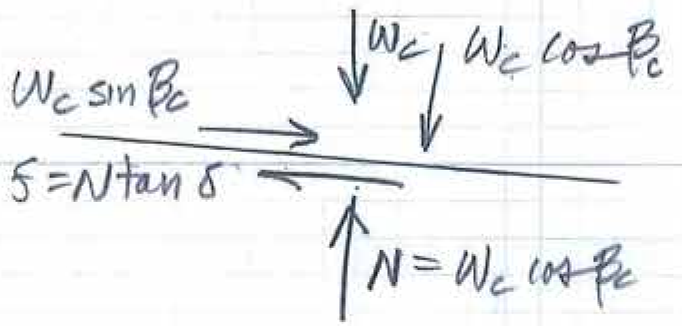
Passive Block

$a = (155 - 104)$ $b = 0$ $h = 110'$
$= 51'$

$\text{Area } A = \frac{(a+b)}{2}(h) = \frac{(51+0)}{2}(110) = 2805 \text{ sf}$

$W_p = \gamma A = \frac{(48.7)(2805)}{1000} = 137 \text{ K}$

Central Blocks Forces



$\beta_c = 1.5°$

$\delta = \cancel{23°}$ 18°

$W_c = 4467$ K

$W_c \sin \beta_c = (4467)(\sin 1.5) = 117$ K

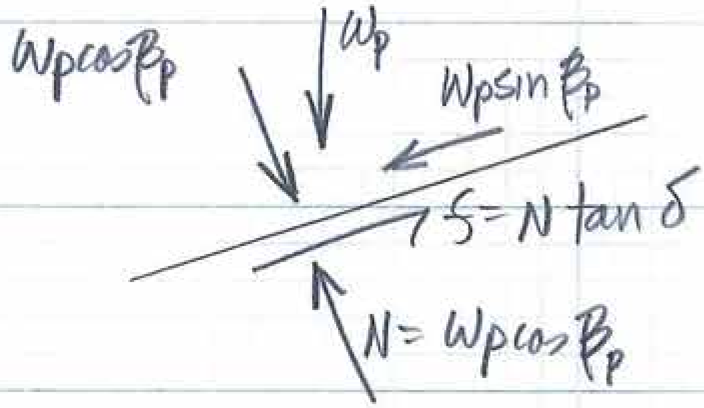
$W_c \cos \beta_c = (4467)(\cos 1.5) = 4465$ K $= N$

$f = N \tan \delta = (4465)(\tan \cancel{23})$ 18° $= \cancel{1895}$ 1450 K

$\searrow \Sigma F = W_c \sin \beta_c - f = 117 - \cancel{1895}$ 1450 $= \cancel{-1778}$ −1333 K

$= P_c$

Passive Block Forces



$\beta_p = 18.3°$

$\delta = \cancel{23°}$ 18°

$W_p = 137$ K

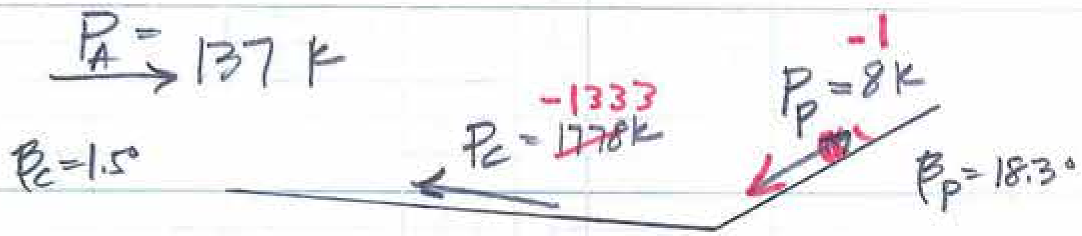
SHEET 3 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Ches Pen
BY CKA DATE 7/19/20 DESCRIPTION Cell 10 Sliding Block
CHK. BY PGS DATE 9/1/21

$W_p \sin\beta_p = (137)(\sin 18.3) = 43\ K$

$W_p \cos\beta_p = (137)(\cos 18.3) = 130\ K = N$

$f = N\tan\delta = (130)(\tan \underset{18}{\cancel{23}}) = \underset{42}{\cancel{55}}\ K$

$x \nearrow \Sigma F = f - W_p \sin\beta_p = \underset{42}{\cancel{55}} - 43 = \underset{-1}{\cancel{8}}\ K = P_p$



Resolve Forces in the Horizontal Direction

$P_{ch} = P_c(\cos\beta_c) = (\overset{1333}{\cancel{1778}})(\cos 1.5) = \overset{1332}{\cancel{1777}}\ K$ ✓

$P_{ph} = P_p(\cos\beta_p) = (\overset{1}{\cancel{8}})(\cos 18.3) = \overset{1}{\cancel{7}}\ K$ ✓

Σ Driving forces $= P_A + P_{ph} = (137 + \overset{-1}{\cancel{7}}) = \overset{137}{\cancel{144}}\ K$

Σ Resisting forces $= P_{ch} = \overset{1332}{\cancel{1777}}\ K$

$$FS = \frac{\Sigma\text{Resisting forces}}{\Sigma\text{Driving Forces}} = \frac{\overset{1332}{\cancel{1777}}}{\underset{137}{\cancel{144}}} = \overset{9.7}{\cancel{12.3}}$$

2018-

SHEET 4 OF 5 PROJECT NO. 3854 PROJECT NAME Ches Ter
BY JCA DATE 7/19/20 DESCRIPTION Cell 10 Sliding Block
CHK. BY PGS DATE 9/1/21

Add Seismic Influence

$a = 0.065$

$C_S = a/2 = 0.0325$

$K_h = 0.0325$

$$P_A' = K_h(W_A) = (0.0325)(274) = 9\text{ K}$$

$$P_{Ch}' = K_h(W_C) = (0.0325)(4467) = 145\text{ K}$$

$$P_{Ph}' = K_h(W_P) = (0.0325)(137) = 4\text{ K}$$

The additional seismic forces act towards downslope.

$$\Sigma \text{ Driving Forces} = (P_A + P_A') + P_{Ch}' + P_{Ph} = (137+9) + \overset{137}{\cancel{145}} + \overset{1}{\cancel{7}} = \overset{284}{\cancel{298}}\text{ k}$$

$$\Sigma \text{ Resisting Forces} = P_{Ch} + P_{Ph}' = (\overset{1332}{\cancel{1777}} + 4) = \overset{1336}{\cancel{1781}}\text{ k}$$

$$FS = \frac{\Sigma \text{ Resisting Forces}}{\Sigma \text{ Driving Forces}} = \frac{\overset{1336}{\cancel{1781}}}{\underset{284}{\cancel{298}}} = \cancel{6.0}\ 4.7$$

SHEET 5 OF 5 PROJECT NO. 2018-3854 PROJECT NAME Chester

BY JCA DATE 7/19/20 DESCRIPTION Cell 10 Sliding Block

CHK. BY PGS DATE 9/2/21

ADVANCED GeoServices
a Montrose Environmental Group company

ATTACHMENT 9K

Geotextile Soil Retention

ADVANCED GeoServices a Montrose Environmental Group company	**Subject:** Geotextiles – Soil Retention		
	Job No. 2018-3854	**Made by:** JCA	**Date** 07/15/20
	Ref.	**Checked by:** VER	**Sheet** 1 of 2

Reviewed by PGS 09/01/2021

Objective:

The objective of this analysis is evaluate the soil retention of the nonwoven geotextiles chosen for the design against the poorly-graded, sandy soils onsite.

Design Approach and Assumptions:

The greater the size of the void spaces in a geotextile, the greater the flow of liquid that will be allowed through it. However, there is a point where the soil particles on the "upstream" side begin to migrate through the geotextile with the liquid flow. Over time, the loss of soil on the upstream side lead to larger and larger void spaces created on the upstream side until the upstream soil structure begins to collapse. This may result in the formation of localized, isolated settlement features that can continue to enlarge with time.

Excessive soil loss is prevented by the void spaces in the geotextile being small enough to retain the soil particles while still allowing adequate flow. Initially, some fine particles will migrate through the geotextile as the flow regime begins and the soil and geotextile respond accordingly. The relatively large fraction of the soil particles will eventually block the finer particles from migrating through the geotextile. Therefore, it is the larger fraction of soil particles that are targeted in this analysis.

1. Manufacturer's data was used for product data related to this analysis.

2. The soil gradation from PMW-13A (bag sample) was selected for use in this analysis because it qualitatively seems rather typical of the sandy soils at the site. The gradation plot was used to estimate various particle diameters for use in analysis.

3. The coefficients C'_u , and C_c were compared to the soil retention design criteria from Koerner 1998 (after Luettich, *et al*).

Calculations:

1. The proposed nonwoven, needle-punched geotextile has Apparent Opening Size, AOS, values that vary based on the product weight. The AOS is defined as the 0_{95}, the 95% opening size. The three select geotextile weights are as follows:

Geotextile Weight (oz/sy)	0_{95} (mm)
6	0.212
8	0.180
10	0.150
16	0.150

From the soil gradation plot, the particle diameter at which 85% of the soil is finer, d_{85}, is 0.38 mm. From Koerner 1998, an acceptable 0_{95} value for a given soil is :

$$0_{95} = AOS < (2 \text{ or } 3)d_{85}$$
$$\text{in this case,} = 0.76\text{mm to } 1.14 \text{ mm.}$$

2. From Holtz and Kovacs 1981, and Koerner 1998, the coefficients C'_u , and C_c are defined as follows:

$$C'_u = \text{SQRT}\ (d'_{100}/d'_0) \qquad \text{and} \qquad C_c = (d_{30})^2 / (d_{60})(d_{10})$$

These calculations indicate the C_c and C'_u values are 2.65 and 2.02, respectively. Using the soil retention criteria from Koerner 1998, a C_c value that favors a retention function is characterized by:

$$1 < C_c < 3.$$

Additionally, a favorable geotextile for soil retention is characterized by:

$$0_{95} < (1 \text{ to } 2)\ C'_u(d'_{50})$$
$$\text{in this case} = 0_{95} < 0.525 \text{ mm to } 1.051 \text{ mm.}$$

Conclusions:

Based on the foregoing, the following conclusions are presented:

1. The nonwoven, needle-punched geotextiles selected for design when compared with poorly-graded, sandy soils selected exhibit acceptable filtration and soil retention properties. However, the use of the on-site soils in any application will be based on a number of factors, not just this analysis.

2. This analysis should be performed for actual soils and actual geotextiles used prior to construction.

References:

1. Koerner, R.M.; *"Designing With Geosynthetics"*; 4th Ed., Prentice-Hall, Inc., 1998; Section 2.2.3.
2. Holtz, R.D., and Kovacs, W.D.; *"An Introduction to Geotechnical Engineering"*; Prentice-Hall, Inc., 1981.
3. Golder Associates Inc.; Site-specific soils testing.; P.N. 063-1431-003; Dec 2013.
4. GSE product data.

ADVANCED GeoServices
a Montrose Environmental Group company

Project:
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By: JCA **Date:** 07/15/20
Checked: VEF VEF **Date:** 7/15/20
Subject: Geotextiles - Soil Retention

Description

Evaluate the proposed geotextiles against the onsite soils and their use.

Soil Retention and Separation

Onsite Soils

d_x = the partical size, d, at which x percent is finer.

d'_{100} = 0.49 mm
d_{85} = 0.38 mm
$2d_{85}$ = 0.76 mm
$3d_{85}$ = 1.14 mm
d_{60} = 0.26 mm
d'_{50} = 0.24 mm
$2d'_{50}$ = 0.48 mm
d_{30} = 0.18 mm
$(d_{30})^2$ = 0.0324 mm^2
d_{10} = 0.047 mm
d'_0 = 0.12 mm

Coefficient of Curvature, $C_c = (d_{30})^2 / (d_{60} \times d_{10})$ = 2.65

Coefficient of Uniformity, $C'_u = SQRT((d'_{100} / d'_0)$ = 2.02

$C'_u d'_{50}$ = 0.485
$2C'_u d'_{50}$ = 0.970

Proposed Geotextile(s)

Type = non-woven, needle-punched (NW-NP-GT)

6 oz/sy GT-NW-NP Apparent Opening Size, AOS = 0.212 mm
Is AOS < $2d_{85}$? **Yes** *to $3d_{85}$?* **Yes**
Is AOS < $C'_u d_{50}$? **Yes** *to $2C'_u d_{50}$?* **Yes**
Permitivity, ψ = 1.5 sec^{-1}
Cross-Plane Water Flow Rate, k_n = 110 gpm/ft^2 = 6.02E-02 cm/sec
Thickness, $t = k_n / \psi$ = 4.01E-02 cm = 1.58E-02 in

8 oz/sy GT-NW-NP Apparent Opening Size, AOS = 0.180 mm
Is AOS < $2d_{85}$? **Yes** *to $3d_{85}$?* **Yes**
Is AOS < $C'_u d_{50}$? **Yes** *to $2C'_u d_{50}$?* **Yes**
Permitivity, ψ = 1.3 sec^{-1}
Cross-Plane Water Flow Rate, k_n = 95 gpm/ft^2 = 5.20E-02 cm/sec
Thickness, $t = k_n / \psi$ = 4.00E-02 cm = 1.57E-02 in

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Checked:	VEF	**Date:**	7/15/20
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10 oz/sy GT-NW-NP Apparent Opening Size, AOS = 0.150 *mm*

Is AOS < $2d_{85}$? **Yes** *to $3d_{85}$?* **Yes**

Is AOS < $C'_u d_{50}$? **Yes** *to $2C'_u d_{50}$?* **Yes**

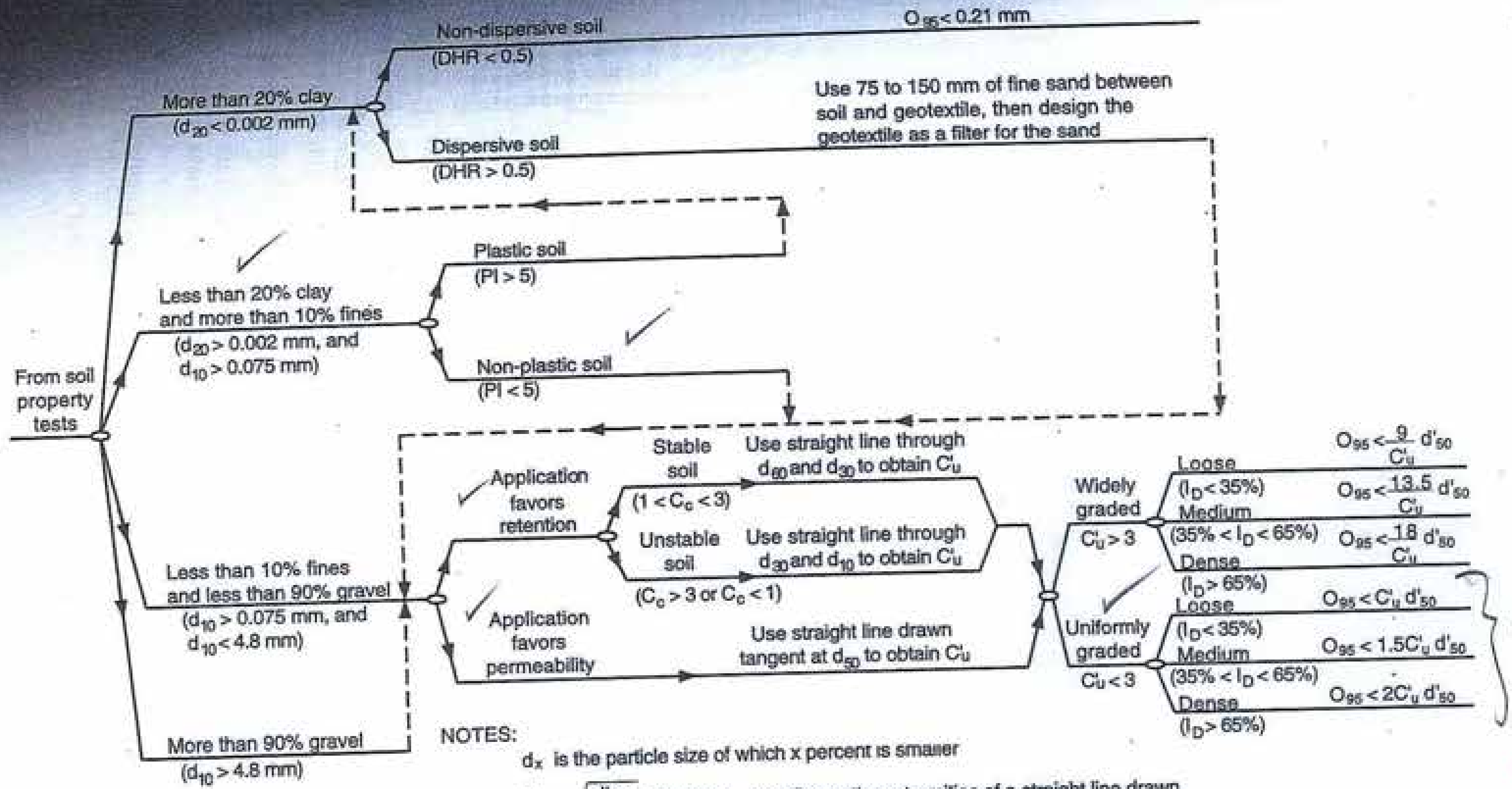
Permitivity, ψ = 1 *sec^{-1}*

Cross-Plane Water Flow Rate, k_n = 75 *gpm/ft^2* = 4.10E-02 cm/sec

Thickness, $t = k_n / \psi$ = 4.10E-02 cm = 1.62E-02 in

References

1 *Koerner, R.M.; "Designing With Geosynthetics"; 4th Ed., Prentice-Hall, Inc 1998; Section 2.2.3.*
2 *Holtz, R.D., and Kovacs, W.D.; "An Introduction to Geotechnical Engineering"; Prentice-Hall, Inc., 1981.*
3 *Site-specific soils testing; Golder Associates Inc.; P.N. 063-1431-003; Dec 2013.*
4 *GSE product data.*



NOTES:

d_x is the particle size of which x percent is smaller

$C'_u = \sqrt{\frac{d'_{100}}{d'_0}}$ where d'_{100} and d'_0 are the extremities of a straight line drawn through the particle-size distribution, as directed above; and d'_{50} is the midpoint of this line.

$C_c = \frac{(d_{30})^2}{d_{60} \times d_{10}}$

I_D = relative density of the soil
PI = plasticity index of the soil
DHR = double-hydrometer ratio of the soil

Figure 2.4 (a) Soil retention criteria for geotextile filter design using steady-state flow conditions. (After Luettich et al. [6])

REFERENCE 1
pg 1/1

Koerner 1998

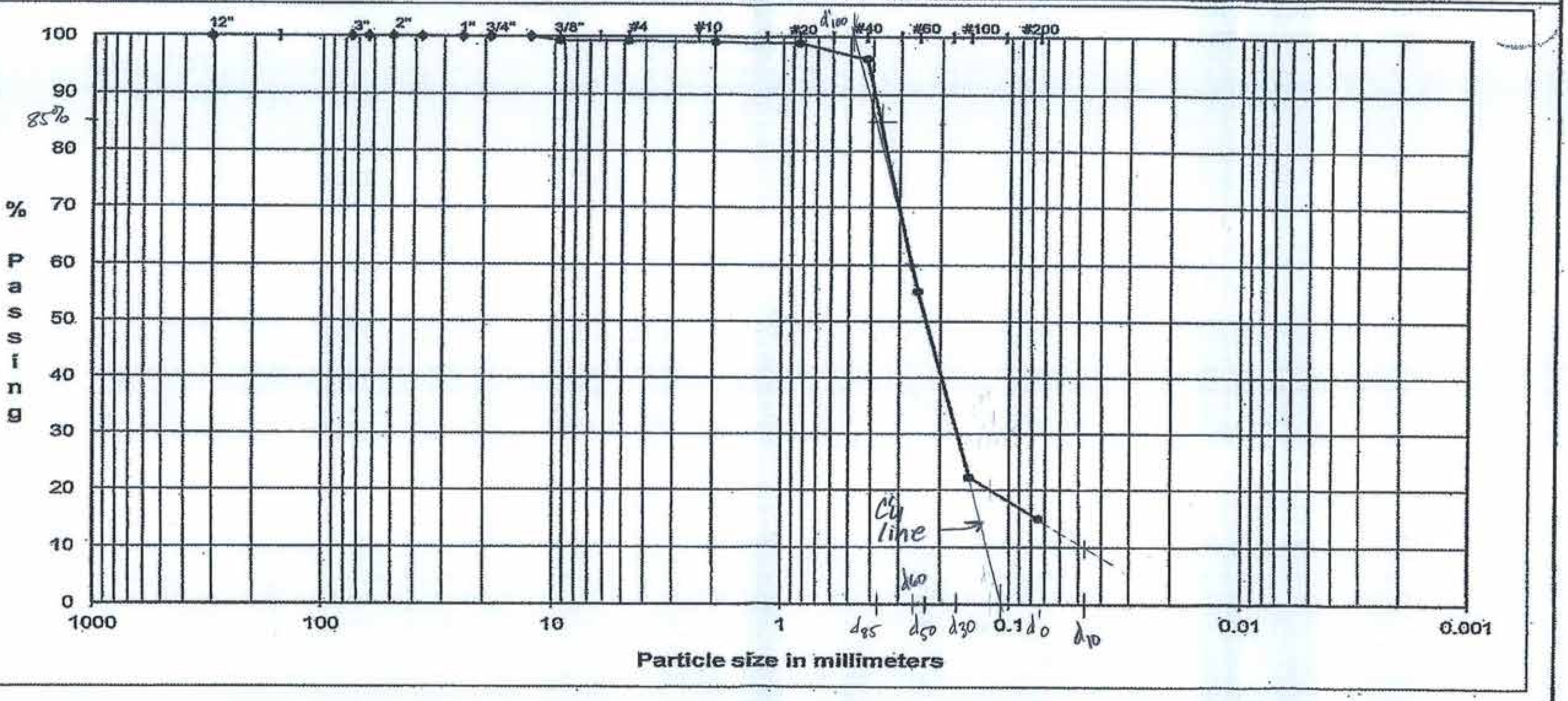
REFERENCE 3
Pg 1/1

DECEMBER 2013 **063-1431-003**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D6913, D4318

PROJECT NAME: NWM/CHESAPEAKE TERRACE SFI/MD
SAMPLE ID: PMW-13A Depth: -
TYPE: Bag



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

1 to $C'_u d_{50} = (2.02)(0.24) = 0.48$

$C_c = \frac{(d_{30})^2}{(d_{60})(d_{10})} \approx 2.6$

$d_{60} \simeq 0.26mm$ ✓ $d_{85} = 0.38mm$ ✓

$d_{30} \simeq 0.18mm$ ✓ $d_{10} \simeq 0.047mm$ ✓

$C'_u = \sqrt{\frac{d'_{100}}{d'_0}} = \sqrt{\frac{0.49}{0.12}} = 2.02$

$d'_{100} = 0.49 mm$

$d'_0 = 0.12mm$

$d_{50} = 0.24 mm$

$O_{95} < 2C'_u d_{50}$

$< (2)(2.02)(0.24) = 0.97 mm$

REFERENCE 4 Pg 1/1

PRODUCT DATA SHEET

GSE Nonwoven Geotextiles

GSE Nonwoven Geotextiles are a family of staple fiber needlepunched geotextiles. The geotextiles are manufactured using an advanced manufacturing and quality system to produce the most uniform and consistent nonwoven needlepunched geotextile currently available in the industry. GSE combines a fiber selection and approval system with an in-line quality control and a state-of-the-art laboratory to ensure that every roll shipped meets customer specifications.

[*]

AT THE CORE:
A family of geotextiles used for separation, filtration, protection and drainage applications.

Product Specifications

These product specifications meet GRI GT12, GRI GT13 and AASHTO M288

Tested Property[1]	Test Method	Frequency	Minimum Average Roll Value					
			NW4	NW6	NW8	NW10	NW12	NW16
AASHTO M288 Class			3	2	1	>1	>>1	>>>1
Mass per Unit Area, oz/yd^2	ASTM D 5261	90,000 ft^2	4	6	8	10	12	16
Grab Tensile Strength, lb	ASTM D 4632	90,000 ft^2	120	170	220	270	320	390
Grab Elongation, %	ASTM D 4632	90,000 ft^2	50	50	50	50	50	50
CBR Puncture Strength, lb	ASTM D 6241	540,000 ft^2	303	435	575	725	925	1,125
Trapezoidal Tear Strength, lb	ASTM D 4533	90,000 ft^2	50	70	95	105	125	155
Apparent Opening Size, Sieve No. (mm)	ASTM D 4751	540,000 ft^2	70 (0.212)	70 (0.212)	80 (0.180)	100 (0.150)	100 (0.150)	100 (0.150)
Permittivity, sec^{-1}	ASTM D 4491	540,000 ft^2	1.8	1.5	1.3	1.0	0.8	0.7
Water Flow Rate, gpm/ft^2	ASTM D 4491	540,000 ft^2	135	110	95	75	60	50
UV Resistance % retained after 500 hours	ASTM D 4355	per formulation		70	70	70	70	70
TYPICAL ROLL DIMENSIONS								
Roll Length[2], ft			300	300	300	300	300	300
Roll Width[2], ft			15	15	15	15	15	15
Roll Area, ft^2 Roll Area (yd^2)			4500 500	4500 500	4500 500	4500 500	4500 500	4500 500

NOTES:

- [1]The property values listed are in weaker principal direction. All values listed are Minimum Average Roll Values except apparent opening size in mm and UV resistance. Apparent opening size (mm) is a Maximum Average Roll Value. UV is a typical value.
- [2]Roll lengths and widths have a tolerance of ±1%.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP] For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

SECTION 10

LEACHATE MANAGEMENT SYSTEM

TABLE OF CONTENTS

LIST OF ATTACHMENTS

Attachments

10A - Leachate Generation Rates
10B - Geocomposite Drainage Layer Permeability
10C - Leachate Collection Pipes Flow Capacity
10D - Leachate Collection Pipe Stress
10E - Peak Daily Flows from Each Cell
10F - Leachate Pump Sizing Calculations
10G - Leachate Generation over Landfill Life
10H - Leachate Storage Facility Secondary Containment
10I - Force Main Sizing Calculations
10J - Environmental Recovery Corp. Leachate Disposal Letter

10.0 LEACHATE MANAGEMENT SYSTEM

COMAR Section 26.04.07.16 (C)(2) requires a liner system to be “designed, constructed, and installed to contain and facilitate the collection of leachate generated in the landfill in order to prevent the migration of pollutants out of the landfill to the adjacent subsurface soils, ground water, or surface water.”

10.1 Introduction

There are 21 rubble landfill cells/subcells, each with a leachate collection system.

The Proposed Liner System for the Chesapeake Terrace Rubble Landfill includes the following, from top to bottom:

- Four feet of Select Waste
- 10 ounce per square yard (oz./s.y.) nonwoven geotextile for layer separation and visual indicator if breached;
- Two feet of leachate collection layer, comprised of locally mined sandy soils;
- A geocomposite drainage layer (GDL), consisting of a tri-planar drainage net with a minimum 8 oz./s.y. nonwoven geotextile heat-bonded to both sides;
- 60 mil HDPE Geomembrane; and,
- Prepared subbase with a minimum thickness of 2 feet and having a permeability less than or equal to 1.0 x 10^{-5} cm/sec.

Leachate percolation through rubble waste headers and laterals along the cell floor, graded at minimum three percent (3%) slope and two percent (2%) slopes, respectively, at the time of construction, to a sump with a submersible pump contained in a 24-inch diameter HDPE carrier, or sideslope riser, pipe.

Leachate is pumped from each cell sump through a pump house to one of five force main, discharging to one of two leachate storage facilities. Each leachate storage facility has two 500,000-gallon leachate storage tanks, i.e., 1,000,000-gallon storage capacity per facility.

The following list indicates Drawings associated with Leachate Collection System Grading and installation of Leachate Pumps, Force Mains, and Storage Tanks.

- Drawing 17 – Top of Leachate Collection System Grading Plan and Layout - West Section
- Drawing 18 – Top of Leachate Collection System Grading Plan and Layout - East Section
- Drawings 19-21 – Leachate Collection System Details
- Drawings 22-23 – Leachate Force Main Details
- Drawings 24-25 – Leachate Force Main Profiles
- Drawing 26 – Leachate Pump House Details
- Drawing 27 – Leachate (Pump) Control Panels Layout Main Details
- Drawings 28 – 29 –Leachate Storage Tank Details

10.2 Leachate Production Estimates

The computer program, Hydrologic Evaluation of Landfill Performance (HELP) version 3.07 was used to estimate the amount of leachate percolation through rubble waste onto the cell leachate collection system (see Section 10.3).

To determine the most efficient manner to provide leachate management for the facility over the life of landfill construction and operation, HELP analyses were performed for a range of filling conditions (i.e., first lift, mid-lift, full-height, etc.) to understand the peak daily leachate generation rates. These conditions were evaluated for a range of cell floor slope conditions, for a unit area of 1-acre, so it would be easy to extrapolate leachate generation rates for each cell, based on cell area. Peak Daily Leachate Generations rates were used to size leachate collection system headers and laterals (in the cells), leachate sump pumps, and leachate force mains.

The peak daily leachate generation was used for varying fill conditions to construct a timeline of filling and new cells coming online with other cells were being closed. Using this sophisticated timeline, the peak daily leachate was determined and used for sizing the leachate storage tanks.

HELP Analysis Methodology is described further in Section 10.7. Summary of Analyses for Leachate Generation is in Section 10.9.

10.3 Leachate Collection System COMAR Regulations

The rubble landfill leachate collection system design is based on adherence to the following COMAR requirements:

- 26.04.07.16C (3): Liner system components, comprised of layers of construction materials and thicknesses in conformance with this regulation, are specified on Drawing 14.
- 26.04.07.16C (6)(a): In accordance with this regulation, there is minimum 3-foot vertical buffer distance (after landfill settlement) between the highest anticipated groundwater elevation (as defined in the Phase II Report) and the bottom of each cell sump's prepared subbase components (see Section 4.0 herein).
- 26.04.07.16C (3)(e): Three percent (3%) minimum cell floor slope at the time of construction is provided in all cells, as shown on Drawings 10 and 11, to meet the regulatory-required two percent (2%) slope after differential settlement.
- 26.04.07.16 C (7)(d): Less than 30 centimeters (1 foot) of leachate head on the liner required by this regulation is achieved by utilization of HELP Analysis Methodology in Section 10.7. Results of all HELP Analyses (see Section 10.9 and Attachment 10A) indicate less than 1-foot head on the liner is achieved with the Alternate Liner System specified.

10.4 Leachate Pumps

Submersible pumps and accessories will be manufactured by EPG Companies. Existing electrical power supply for pump operation is located near the site in Patuxent Road and Conway Road rights-of-way.

Pump sizes were selected based upon the peak daily leachate production under “first lift” conditions. As shown on the "Cell Pump List" on Drawing 27 and in Section 10.9.3, one pump in each cell sump is sufficient to remove leachate under the peak daily generation scenario, described further in Section 10.9. A spare pump will be provided during construction of each cell for storage in the associated Leachate Pump House for immediate installation when the installed pump needs annual servicing or malfunctions.

10.4.1 Pump Level Sensors and Alarm Systems

A level sensor for each submersible pump will be provided in all cell sumps. Leachate levels will be monitored in the pump control panel, mounted on the Pump House wall (see Drawing 26). Level sensor pump-off position will be 6 inches above the sump floor. Pump-on position will be 12 inches above sump floor, and pump high-level alarm will be 16-inches above the sump floor, per COMAR Regulations (See detail on Drawing 19). See Drawing 19 for materials to be placed in cell sumps, and depiction of pump control positions.

Equipment in the Pump Control Panel, provided by the Pump Manufacturer, will monitor and record leachate levels in the landfill cells. In the event of high-level alarm occurrence, a light at the Pump Control Panel will be activated. During landfill operating hours, the alarm signal will be electronically transmitted to the Scale House. During landfill non-operation hours, the landfill manager and Superintendent will receive a high-level alarm signal, via electronic telemetry from the Pump Control Panel. If a caretaker is not provided, a designated landfill employee will receive the high-level alarm signal offsite, via telemetry.

A Master Control Panel will be located in the Leachate Storage Facility Controls Building (located as shown on Drawing 10). This Master Control Panel will include a display for each Cell pump as well as each Leachate Storage Tank. The controls for cells sump pumps and the storage tanks will be interconnected so that high liquid levels in the tanks will trigger an alarm and notification to the landfill manager, care taker, or landfill employees and shut-off the cell sump pumps.

See Section 12, "Operations Plan" for actions taken by landfill personnel as response to pump high-level alarm activation.

10.4.2 Pump Access and Maintenance

Access to the pumps within 24-inch HDPE sideslope riser pipes is provided by means of stainless steel pulling cables as shown on Drawing 19. The Landfill Perimeter Berm and Pump House are designed to provide equipment access, as necessary to install and remove pumps. As shown on Drawing 26, an 8 ft wide doorway, preferably an industrial roll-up overhead door, allows access to both pump carrier pipes.

The Landfill Perimeter Berm top width is designed to allow access for Pump Installation and Removal Equipment (i.e., equipment mounted with boom and winch, with steel cable for attachment to the pumps stainless steel pulling cable). Pump Installation and Removal Equipment access across the perimeter channels to the top of the Landfill Perimeter Berm will be provided by installation of a precast concrete or steel ramp. The details for the precast ramps are provided on Drawings 19, 23, and 40.

Upon receipt of an order for a pump, the Pump Manufacturer will provide a Pump Operations and Maintenance (O&M) Manual, prepared based on site specific application. The Pump O&M Manual is included with delivery of each pump to a specified site. A listing of a typical EPG Companies, Inc. Pump O&M Manual along with other Pump Manufacturer's Literature is provided in Section 10.4.3 below.

10.4.3 Pump Manufacturer's Accessories

In addition to pumps and alarm system described above, the Pump Manufacturer will provide accessories and appurtenances that will be used for the landfill's leachate pump and conveyance systems. Pump Manufacturer's Literature typically includes:

- Information regarding the pump itself (including pump curves for site specific pumps); stainless steel check valves on pump discharge lines in the Pump House and leak detection sensor on the Pump House floor; Pump Control Panels; Level Sensor and Monitoring Equipment; Flow Metering and Control Devices; SCADA (Supervisory Control and Data Acquisition) and Telemetry Equipment.
- Pump description, illustrations, capacities, materials of construction; suitability for Class 1, Division 1 & 2 application; and Engineer's Specification Sheet for pump order;
- Pump curve for pump(s) in each cell sump, with system TDH/GPM line intersects indicative of the specified pump's capacity;
- Pump Control Panel description, illustrations, and Series L950PT Engineers Specification;
- Level meter, level sensor, bellows, LMSA level monitoring system, tank gauging system and sensor data sheets;
- Alarm system data acquisition, SCADA and telemetry;
- Flow metering and control devices;
- Miscellaneous accessories (stainless steel check valves and leak detection sensor); and,

- EPG Companies, Inc. provides a Pump O&M Manual for each pump delivered to a site, based on the pump's site-specific requirements.

10.5 Leachate Force Mains and Sideslope Riser Pipes

All pipes associated with landfill cell construction (excluding stainless steel pipes at select locations) will be High Density Polyethylene (HDPE), manufactured by Performance Pipe, or approved equal.

The Sideslope Riser Pipe has among the lowest loading for the piping at the site, due the Sideslope Riser being located along the outer edges of the landfill. The Sideslope Riser with the highest load is in Cell 7, with a sump elevation of 102 ft MSL and a top of closure cap grade immediately above the sump of approximately 208 ft MSL, for a net load of 106 feet (8 feet of soils and 98 feet of rubble waste). Previous calculations conducted by the local Performance Pipe Distributor, Lee Supply Company, Inc., for loading of the 24-inch perforated Sideslope Riser pipe show adequate strength and performance for a maximum burial depth of 138 feet (15 feet of soil and 123 feet of rubble waste). This calculations are repeated in Attachment 10I.

The force main has been specifically designed to have a minimum depth of 3.5 feet in the side of the perimeter (access) road. This depth was selected to provide adequate protection for the HS20 loading of the waste trucks as well as frost depth.

10.6 Leachate Storage Tanks

As shown on Drawings 28 and 29, leachate from the entire landfill is conveyed to two leachate storage facilities, each with two 500,000-gallon storage tanks inside a secondary containment area. Each secondary containment area is comprised of concrete floor and walls, designed for 500,000 gallons containment capacity, with 1-foot freeboard to top of berm, as shown on Drawing 28. To prevent storage tank overflow, Pump Manufacturer will provide tank-gauging systems, under which an alarm would be activated and all leachate pumps, pumping to a tank filled to near capacity, would automatically shut down, per description under Section 10.4.1.

Storage tanks will be 45-foot diameter, glass coated, bolted steel Aquastore Tanks, manufactured by Engineered Storage Products, Inc. Specifications of these tanks are provide in Section 14, Technical Specification Section 02653.

10.7 Leachate Production - HELP Analysis Methodology

The HELP computer program models climatologic, soil, and design data and utilizes a solution technique that accounts for infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage over a specified time period. A 1-year time period was used for a variety of filling active conditions, per unit area of cell. This allowed apply the leachate generation rates per acre of cell to all cells by simply multiplying the leachate generation rates by the area of each cell.

The program uses climatologic, soil, and landfill design data to produce daily estimates of water moving across, into, through, and out of landfills. To accomplish this, daily precipitation is partitioned to maintain a water budget. The following describes the data fields in detail:

- Climatologic Data - Climatologic data includes daily precipitation, mean monthly temperatures, mean monthly insolation, leaf area indices, vegetative cover, and winter cover factors. These values may be entered manually or default climatologic data for 102 cities is available in the HELP program. Based on nearest proximity to the landfill, default rainfall for Baltimore, Maryland was used, with average rainfall and average precipitation modified to reflect average values for Anne Arundel County, Maryland, from the National Oceanic and Atmospheric Administration (NOAA).
- Soil Data - Soil data includes material types used in the landfill and the characteristics of the material, i.e. vertical percolation, lateral drainage, barrier soils, or geomembrane liners. Material properties such as thickness, porosity, field moisture capacity, wilting point, initial material water content, and effective saturated hydraulic conductivity are used in the evaluation. Geosynthetic properties and installation construction such as pinhole density, installation defects, and placement quality are considered. HELP 3 provides default values for the properties of 42 material types. The user may edit these values.
- Design Data - Design data includes information that models the layout of the landfill such as total surface area, material layer thickness, and drainage slope and length. Other data such as surface runoff curve number, membrane leakage fraction, and potential runoff fraction may be requested by the program for certain materials.

Once the input is entered, the HELP program is used to evaluate the landfill design for the specified one-year time period for active landfilling conditions. The model runs simulations for 30-years for the closed conditions. However, after seven years of closed condition, the model shows a leachate generation of zero.

HELP performs water budget calculations by modeling each of the hydrologic processes that occur and outputs information used to design components associated with the landfill's leachate collection, conveyance and storage.

10.8 Analyses for Post-Closure and Peak Daily Leachate Production

The landfill will be constructed and filled with rubble waste in accordance with conditions specified on Drawing 63, "Sequence and General Notes for Construction" and Intermediate Construction Stage Plans on Drawings 64 through 81. As shown on Intermediate Construction Stage Plans, surface runoff in areas adjacent to a cell under construction will be diverted around the cell, during cell construction and as the cell is filled with rubble waste. Therefore, leachate production for the entire landfill will primarily be limited to precipitation that falls directly within the cell as waste is being placed, during the life of landfill construction and operation.

To determine the most efficient manner to provide leachate management over the life of landfill construction and operation, the following HELP analyses were performed:

- Analysis #1 – Active Landfilling, covering a range of waste thickness from “first lift” through “17 Lifts” to determine the peak daily rate of leachate production under each scenario and floor slope condition. The maximum per acre “first lift” leachate production rate was used for sizing the cell pumps and the leachate collection layer header pipes in the cells.
- Analysis #2 – Closed condition for various list conditions (impacts duration and length of leachate being released from cell due to moisture storage in the waste). This scenario in tandem with the peak daily rates developed under Analysis #1, were used with the cell sequencing and landfill timeline to determine the peak leachate generation when multiple cells were undergoing various stages of filling and closure.

10.9 Develop Leachate Generation Rates

The Liner System Configuration and input data in summarized in the Table 1, below.

Table 1 - Summary of Liner System Soil and Material Data

Layer	Description	HELP Default Soil
1	12 inches intermediate cover cover	6
2	96 inches of waste	19
3	48 inches of Select Waste	19
4	24 inches of gravel/course sand	6
5	Tri-planar GDL	34 (modified k = 4.4 cm/sec)
6	60 mil HDPE geomembrane	35
8	36 inches natural soils	5

The Closure Cap (Final Cover) System configuration and input data is summarized in Table 2 below:

Table 2 - Summary of Closure Cap System Soil and Material Data

Layer	Description	HELP Default Soil
1	6 inches of vegetative support layer	9
2	18 inches of protective cover	6 (modified k = 1x10-5 cm/sec)
3	GDL	34 (modified k = 12.8 cm/sec)
4	40 mil LLDPE geomembrane	36
5	24 inches Final cover	6

The waste properties were assumed to be consistent with municipal solid waste with channeling. Channeling is expected to occur in the rubble waste. No runoff was allowed under active landfilling conditions, forcing all rainfall to be treated as leachate.

The per acre peak daily generation rates developed under Analysis #1 (which indicate less than 1-foot head on the landfill's textured 60-mil HDPE liner, for each HELP3 Run) are included in the table below.

Table 3 - Summary of Peak Daily Leachate Generation (cf/acre/day)

Total Waste Thickness *(ft)*	**Leachate Collection System Drainage Slope (%)**					
	2	***3***	***4***	***5***	***6***	***33***
First Lift						
8	1100	1224	1300	1300	1214	1655
Mid-Fill						
20	788	793	802	785	836	1001
32	839	832	1011	837	854	1001
52	883	924	838	864	841	1001
68	885	921	832	843	842	1001
Full-Fill						
40	1031	1070	1028	1028	1096	977
64	963	978	975	980	944	1031
104	1058	1062	1113	1110	933	1024
136	1012	1022	1030	1027	985	993

Based on the summary table above, the peak leachate generation rates for the flatter sloped cells floors was 1300 cf/acre/day (9,724 gal/ac/day) and 1655 cf/acre/day (12,380 gal/ac/day) for the steeper cell sideslopes. The area in each cell with the shallow slope and the steep slope were multiplied by their corresponding peak leachate generation rate, then added to get the peak daily leachate for the cell. The detailed analyses, with supporting HELP model printouts, are provided in Attachment 10A.

The calculated peak daily flow for each cell, under first lift conditions is as follows:

Table 4 - Summary of Peak Daily Leachate Generation for each Cell				
Cell	**Area of Floor (acre)**	**Area of Slope (acre)**	**Peak Daily Leachate (gal/day)**	**Peak Daily Leachate (gal/min)**
1	11.7	1.5	132,340	91.9
2	5.4	2.1	78,506	54.5
3	4.2	0.7	49,506	34.4
4	4.9	0.6	55,075	38.2
5A	4.7	0.9	56,844	39.5
5B	2.9	0.5	34,389	23.9
5C	3.6	.8	45,405	31.5
5D	1.9	1.0	30,855	21.4
5E	2.3	0.9	33,507	23.3
5F	1.0	0.7	28,340	12.8
6	2.0	3.2	58,788	40.8
7	2.2	4.5	76,826	53.4
8	4.6	1.4	62,327	43.3
9	2.7	1.3	42,348	29.4
10	7.5	2.1	98,193	68.2
11	3.9	3.1	76,963	53.4
12	5.7	1.0	67,806	47.1
13	2.6	0.8	35,186	24.4
14	4.0	0.3	42,609	29.6
15	2.8	1.9	50,748	35.2
16	2.1	2.4	50,131	34.8

Detailed summary and the HELP model output is included in Attachment 10A. Calculations showing the peak flow from each cell are presented in Attachment 10E.

10.9.1 Leachate Lateral Spacing

The initial analysis was to determine the spacing the leachate collection laterals in the leachate collection layers. While the high-flow geocomposite drainage layer (GDL) will quickly convey the leachate which gets to it, a key to landfill design is redundancy. Thus, NWM proposes including a series of perforated leachate collection piping in the 2-foot thick layer of sandy soils immediately atop of the GDL. The header pipe will convey flow from the laterals to the sump. Headers and laterals will be perforated and installed in a stone bedding, then wrapped by a 16 oz/s.y. nonwoven geotextile to maintain layer separation with the surrounding soils and provide additional protection of the underlying geosynthetics from puncture due to possible angularity of the stone bedding.

Based upon a series of HELP model runs, the spacing which maintained a head of less than 12-inches is 250 feet.

10.9.2 Leachate Collection Header and Lateral Sizing

As indicated previously, leachate collection headers and laterals are being include in the leachate collection system design. The pipes will convey any flow they intercept by gravity to the leachate sump in each cell. Based on the peak flow in Cell 1 (the largest cell), the pipe sizes and pipe perforation sizing was confirmed to have adequate capacity of the anticipated flow. The configuration of each system is as follows:

- Leachate collection system header is 8” diameter HDPE pipe
- Leachate collection system lateral is 6” diameter HDPE pipe
- Perforations are 3/8” dia holes, two per row, a row every 6-inches, each row is rotated 90-degrees

Attachment 10C includes these calculations.

10.9.3 Leachate Pumps

Pump sizing is dependent upon two features: required flow rate and head loss to overcome. The required flows for each cell were assumed to be the same as the peak daily flows computed and included in Table 4, above. While the pumps are sized to accommodate this peak daily flow rate, the pump will not be in continuous operation. As indicated elsewhere, the pump will be equipped with transducers, or floats, to monitor leachate levels as it accumulates, so the pump can engage at a pre-determined level and pump down the leachate until the liquid level drops to a pre-set level (usually 6 to 9 inches above the pump intake to avoid burning-out the pump). Then, leachate will be allowed to build again. During drier periods (less rainfall) or after more waste is within the cell, the leachate flow rates will be less and the pump will operate less often.

For landfill application, the elevation difference between the intake and the discharge location is often the biggest driver of the head loss to be overcome. To determine the headloss, the elevation of the sump and the elevation of the discharge at the leachate storage tanks was the static head. The dynamic head is the friction loss associated with the force main pipe. Since smooth-walled HDPE is proposed for the force main, the friction loss is negligible, but actually tabulated using Hazen-Williams equation.

In the end, four pump models were specified for the 21 cells at the site, as summarized in Table 5 and presented in Attachment 10F.

Table 5 - Summary of Sump Pump Sizing for each Cell

Cell or Sub-cell	Peak Leachate Generation (gpm)	Total Head (feet)	Selected Pump
1	91.9	105.9	Model 18-4 HP 5.0
2	54.5	47.2	Model 18-2 HP 3.0
3	34.4	35.2	Model 18-1 HP 1.5
4	38.2	32.8	Model 18-1 HP 1.5
5A	39.5	92.4	Model 18-2 HP 3.0
5B	23.9	88.7	Model 18-2 HP 3.0
5C	31.5	87.4	Model 18-2 HP 3.0

Table 5 - Summary of Sump Pump Sizing for each Cell (continued)			
Cell or Sub-cell	Peak Leachate Generation (gpm)	Total Head (feet)	Selected Pump
5D	21.4	85.7	Model 18-2 HP 3.0
5E	23.3	85.8	Model 18-2 HP 3.0
5F	12.8	87.2	Model 18-3 HP 5.0
6	40.8	98.3	Model 18-3 HP 5.0
7	53.4	105.1	Model 18-3 HP 5.0
8	43.3	99.1	Model 18-3 HP 5.0
9	29.4	95.9	Model 18-2 HP 3.0
10	68.2	104.8	Model 18-3 HP 5.0
11	53.4	62.2	Model 18-2 HP 3.0
12	47.1	61.8	Model 18-2 HP 3.0
13	24.4	58.2	Model 18-1 HP 1.5
14	29.6	56.3	Model 18-1 HP 1.5
15	35.2	53.5	Model 18-2 HP 3.0
16	34.8	55.2	Model 18-1 HP 1.5

*Pumps are made by EPG Companies.

It is possible the manufacturer may adjust the capabilities of these pump models over the life of the landfill construction and operation. As such, cells constructed later in the landfill operation timeline may have to order different pumps, due to manufacturer changes.

10.9.4 Leachate Force Main Sizing

Based on the same data use for leachate sump pump for each cell, the force main sizing can be checked. A previous effort to confirm the force main sizing was done by providing the force main data to the Pipe Manufacturer who performed calculations that indicate all force mains will be 6-inch SDR- 11 HDPE, contained in 10-inch SDR-17 HDPE, on Drawing 22. Pipe Manufacturer's previous force main calculations are in Attachment 10I. While the peak flows and heads have changed since the pipe manufacturer’s calculations, the analysis assumed that all cells discharging through the same force main were pumping the peak flows at the same time, which will not be happening. This is considered a very conservative design and demonstrates the force is more than ample. At the same time, the head loss associated with these flows in a smaller diameter pipe, like a 2-inch force main, are no longer negligible because it would be putting too much flow through the pipe.

10.10 Summary of Leachate Storage Tank Sizing

The landfill will have two Leachate Storage Facilities as shown on Drawings 10 and 11, with details shown on Drawings 28 and 29. Facility No. 1 (for Cells 2 through 4 and 11 through 16) has a drainage area of 48.5 acres. Facility No. 2 (for Cells 1 and 5A through 10) has a drainage area of 65.9 acres.

Sections 10.10.1 and 10.10.2 describe the analysis of the peak flows for the leachate tanks.

10.10.1 HELP Analysis

Using the same simulations from which the peak daily rates were obtained described in 10.9 above, estimates were developed for the entire 12 year operational timeline. In general, multiple cells will be in operation each year – one nearing maximum filling grades, one actively filling, and one just beginning to fill. Due to the variety of cell size, some cells may be developed and operated at the same time as a larger cell. The benefit of the smaller cell size is reduction in leachate management.

Based on the construction sequencing for the landfill cells, there may be cells in operation for less than one year and others in operation for two years.

The following is a description of how the leachate timeline was developed.

1. Since the life of each cell is relatively short – most a few months, some for two (2) years – planning for cell construction will require that multiple cells be “grouped together”.
2. From the HELP modeling, each cell has peak daily flows for the first lift, mid-fill, and full-fill. The mid-fill and full-fill were estimated to be average heights for each cell for timeline design and modeling purposes.
3. From the cell life estimates, each cell has an estimated life, and collectively they provide twelve (12) years of landfilling. For each cell, mid-fill is associated with mid-life, and full-fill is associated with maximum waste grades. Since each cell has a different life, each cell group has a different total life.
4. The first cell is brought into service, and experiences the “first lift” daily peak flow.
5. At mid-life in the first cell, the first cell experiences the “mid-life” peak daily flow. At the same time, the second cell in the group is brought into service, and experiences its “first lift” peak daily flow.

6. At the mid-life of the second cell, it experiences its mid-life peak daily flow. At the same time, the third cell is brought into service with its “first lift” peak daily flow.
7. At mid-life, the third cell experiences its “mid-fill” peak daily flow.
8. All of the cells in the group are presumed to experience their respective full-fill peak daily flows at the end of the total life for the group.
9. Between any of the calculated peak daily flows, between first lift and mid-fill flows, and between mid-fill and full-fill flows, flow values were linearly interpolated.
10. A closure construction period of 10 months was assumed. Between the calculated flows for full-fill and post-closure year 1, peak daily flows for each month were interpolated.
11. Flows during post-closure months between calculated values were interpolated.
12. This arrangement continued for each cell, each group, and through a minimum of 10 years after the last cell is closed. The HELP model output shows that leachate continues

For example, refer to the tables in Attachment 10G, and consider the following:

Step 1: The first cell group includes Cells 11, 16, and 12, in that order.

Step 4: Cell 11 is brought into service, and it has an estimated life of 8 months. In Month 1, the flow is the first lift peak daily flow.

Step 5: At Month 4, the flow from Cell 11 is the mid-fill peak daily flow. Cell 16 is brought into service with its first lift peak daily flow. Cell 16 has an estimated life of 5 months.

Step 6: At month 6, the flow from Cell 11 continues. The flow from Cell 16 is at its mid-fill peak daily flow. Cell 12 is brought into service with its first lift peak daily flow. Cell 12 has an estimated life of 5 months.

Step 7: At month 8, the flows from Cells 11 and 16 continue. The flow from Cell 12 is its mid-fill peak daily flow.

Step 8: In month 18, all three cells experience their respective full-fill peak daily flows. Cell 13 is brought into service with its first lift peak daily flow. Cell 13 is the first cell planned in the next group of cells to be constructed.

Step 10: During the subsequent 10 months after Cells 11, 16, and 12 have been completely filled, closure construction takes place. Leachate flow from these three cells continue. Filling occurs in the next group of cells with their leachate flows.

Step 11: Once closure of Cells 11, 16, and 12 is complete, the leachate flow begins to taper off. By post-closure year 7, modeling indicates flow will have ceased. Concurrently, filling and leachate flow continues from the next group of cells.

During the timeline, peak daily flows each month are summed to estimate the total peak daily leachate flow from the facility. At some point, the facility will experience a maximum total flow – a combination of peak daily flows from cells under different fill conditions, including cells that are being closed, and cells that are actively being filled.

Leachate Storage Facility No. 1 will serve Cells 11, 16, 12, 13, 14, 15, 2, 3, and 4. The peak daily flow is estimated to be 254,933 gallons. This is associated with the following fill conditions:

Leachate Storage Facility No.1
Peak Daily Leachate Flow and Fill Conditions

Location	**Fill Condition**
Cells 11, 16, and 12	Post-Closure
Cells 13, 14, and 15	Closure construction in progress
Cells 2 and 3	At or beyond Mid-Fill
Cell 4	First Lift

Leachate Storage Facility No. 2 will serve Cells 1, 5E, 5F, 10, 9, 5D, 5C, 5B, 8, 5A, 7, and 6. 1, 16, 12, 13, 14, 15, 2, 3, and 4. The peak daily flow is estimated to be 245,579 gallons. This is associated with the following fill conditions:

Leachate Storage Facility No.2 Peak Daily Leachate Flow and Fill Conditions	
Location	**Fill Condition**
Cells 1, 5E, and 5F	Just at Full-Fill
Cell 10	First Lift

It should be noted that this evaluation is conservative as it assumes the peak daily rates for multiple filling conditions coincide. A shift in the peaks so that they do not align is expected. For example, the peak leachate generation from each stage of filling will vary based on the thickness of waste through which the leachate, produced as a result of a rainfall event, will migrate to the sump. A significant rainfall may result in the peak in a first lift condition on the same day as the rainfall, but a peak rate for a cell that is nearly full may not occur for 4 or 5 days after the rain event.

For the post-closure period, flows were based on the peak month of each post-closure year for that waste thickness within that particular cell. The HELP analysis shows that after a few years of closure, the peak month discharges is the same regardless of waste thickness.

During the life of cell construction and waste placement, surface run-on from adjacent areas will be diverted around waste placement areas, as shown on Drawings 38 through 44.

10.10.2 Leachate Storage Tank Selection

Per criteria under Sections 10.10.1, comparing the peak daily with average annual leachate production rates, the peak daily rates are typically three times the average monthly rates. Further, as indicated above, peak operational daily rates assume the peak production in each cell under differing fill conditions occurs on the same date.

If the average daily rates are one-third the peak daily values, then the average daily values is 255,000 gpd/3 = 85,000 gallons/day. By providing 1M gallons of leachate storage capacity in each Leachate Storage Facility, there will be 11 days of on-site storage for <u>average</u> daily flow from the filling condition which produces the highest peak daily operational leachate generation. The leachate generation volume calculations were prepared assuming that installation of the Closure Cap will be completed in groups of 3 cells at a time. This results in between 8.4 and 18.2 acres sitting in “full-fill” conditions when filling operations have been moved to other cells. Sequencing completion of filling in a manner allow installation of the Closure Cap in smaller areas more frequently will help reduce leachate generation rates.

10.11 Leachate Disposal

From the leachate storage tanks, the leachate will be hauled off-site for disposal.

We have received a favorable response from Environmental Recovery Corporation (ERC) of Maryland, located in Baltimore that they do receive rubble landfill leachate and they have provided a preliminary quote for disposal of the leachate. The facility can currently handle up to 50,000 gpd at the Baltimore location and they expect to be completing an expansion of the facility before the proposed landfill comes on-line. They also have a facility that can accommodate the anticipated leachate in Lancaster, Pennsylvania. A copy of the ERC quote and acceptance criteria for disposal is provided in Attachment 10J.

Details and layout of the leachate management system are provided on Drawings 17 through 29. Detailed description pertinent to leachate collection system design and installation is presented in Section 10.0 "Leachate Management System" and in Section 14.0, "Construction Specifications", respectively.

Depending on the nature of the waste disposed, the levels of contaminants in the leachate, and the volume of leachate produced (which is directly linked to the amount of rainfall), the owner may choose, in the future to develop an on-site wastewater treatment plant to treat leachate and obtain a NPDES discharge permit.

ATTACHMENT 10A

Leachate Generation Rates (per acre)

ADVANCED GeoServices a Montrose Environmental Group company	**Subject:** Leachate Generation Estimates		
	Job No. 2018-3854	**Made by:** JCA	**Date** 07/17/20
	Ref.	**Checked by:** VEF	**Sheet** 1 of 7

Reviewed by PGS 08/29/2021

1. Purpose

The purpose of this analysis is to estimate the leachate flow from the landfill.

2. Analysis Approach

a. The life of each cell was estimated based on cell area, the floor grading, the final grading, design thicknesses for the liner and leachate collection system and the cap system, the estimated gate tons of waste received each day, the planned work week, and the estimated waste density. The cell life information is used to plan the modeling of the leachate generation.

b. The landfill is modeled using the computer program, “Hydrologic Evaluation of Landfill Performance” (HELP) Version 3. The HELP computer program models climatologic, soil, and design data and utilizes a solution technique that accounts for infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage over a specified time period.

c. A unit one acre was chosen for modeling. This allows the unit acre flow results to be multiplied by the acreage of each cell to estimate the flow from each cell.

d. Since the cells have brief life spans, most in terms of months, the unit acre was modeled with three general waste thicknesses designated as “First Lift”, “Mid-Fill”, and “Full-Fill”. The waste thickness for the First Lift was 8 feet. This is experienced by each cell.

e. The number of lifts associated with the Full-Fill condition utilized for the modeling ranged from 5 to 17 (see Attached Table 1). In order to have a range of data that shows how the number of lifts affect leachate generation, the Full-Fill condition was modeled with 5, 8, 13, and 17 lifts. Correspondingly, the Mid-Fill condition was modeled with 2.5, 4, 6.5, and 8.5 lifts. (The September 3, 2021 design revisions reduced the number of lifts to 5 to 15, but did not significantly change the cell life because the operating life of the facility is set at 12 years, and the cell areas remained essentially unchanged).

f. Related, the post settlement slope of the landfill floor varies between 2% and 6% with sideslopes of 33%. Therefore, fill condition was modeled with drainage slope values (%) of 2, 3, 4, 5, 6, and 33. This gives a range of data that shows how the peak head buildup peak flow vary with drainage slope for each fill condition.

g. The primary focus of the modeling is to estimate the maximum head buildup on the liner, and the peak leachate flow. Therefore, the liner system is modeled as flawless material with a perfect installation. Also, perform several First Lift models using the lowest slope value to determine the drainage length between leachate pipes that limits the maximum head buildup to 12 inches.

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h. Related to the brief life spans of the cells, each of the lift conditions described were modeled for one year. This is also a consequence of a limitation of the HELP program in that model time frames are units of whole years.

i. The HELP program is allowed to establish the beginning moisture content values for the various soil and material layers for the First Lift condition. These values were noted for use in subsequent models.

   For the Mid-Fill condition, the moisture contents of the First Lift layers were set to the ending values from the First Lift model. The added layers to establish the Mid-Fill condition were set to moisture content values the same as the beginning of the First Lift models.

   For example, a First Lift layer may have started with a moisture content of 0.25, and ended with a moisture content of 0.18. For the Mid-Fill condition, the starting moisture content of that layer was set to 0.18. If that same type of layer was added to establish the Mid-Fill condition, the moisture content of the added layer was set to 0.25. This approach was also used for the transitions from the end of Mid-Fill to the start of Full-Fill, and from the end of Full-Fill to the start of Closed Fill.

j. Although the HELP program includes default climatological data for nearby Baltimore, the modeling was enhanced by using the current average monthly temperature and average monthly precipitation for Baltimore. Thirty (30) years of predicted temperature and precipitation data was generated for use.

   Since the storm water management system is required to be designed for the 25-year, 24-hour storm event, use this value in the predicted precipitation data to enhance the model.

k. Storm water runoff parameters are selected from default HELP data, and from “TR-55, Urban Hydrology for Small Watersheds”.

l. To evaluate the impact of the closure cap on leachate generation, the Closed Fill condition is modeled for a time period of 30 years.

m. From the modeling output, determine the maximum head buildup for each fill condition with each slope value. Also determine the unit leachate production per acre for each fill condition and

3. HELP Program Description

The HELP computer program models climatologic, soil, and design data and utilizes a solution technique that accounts for infiltration, percolation, evapotranspiration, soil moisture storage, and

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lateral drainage over a specified time period. The program uses climatologic data with soil, and landfill design data to produce daily estimates of water moving across, into, through, and out of landfills.

4. Soil, Climatological, and Design Data

a. Climatological Data: The following climatological data was used to enhance the model.

Current Baltimore, MD		
Average Precipitation (in)	**Month**	**Average Temperature (ºF)**
3.47	Jan	32.4
3.02	Feb	35.5
3.93	Mar	43.7
3.00	Apr	53.2
3.89	May	62.8
3.43	Jun	71.7
3.85	Jul	76.5
3.74	Aug	74.5
3.98	Sep	67.4
3.16	Oct	55.3
3.12	Nov	45.5
3.35	Dec	36.6
Total = 41.94		

Additionally, the 25-year 24-hour storm event was confirmed to be 6.16" of precipitation. In the first year of the predicted precipitation data, the precipitation value on the day of highest precipitation was replaced with the value 6.16 to further enhance the modeling.

b. Soil: The following soil and material data was used for the liner system and waste layers.

Summary of Liner System Soil and Material Data		
Layer	**Description**	**HELP Default Soil**
1	12 inches intermediate cover	6
2	96 inches of waste	19
3	48 inches of Select Waste	6
4	24 inches of gravel/course sand	6
5	Tri-planar GDL	34 (modified k = 4.4 cm/sec)
6	60 mil HDPE textured geomembrane Pinhole Density = 0 holes/ac Installation defects = 0 defects/ac	35

	Placement quality = 1, perfect	

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The following soil and material data was used for the closure cap system.

Summary of Closure Cap System Soil and Material Data		
Layer	**Description**	**HELP Default Soil**
1	6 inches of vegetative support layer	9
2	18 inches of protective cover	6 (modified k = $1x10^{-5}$ cm/sec)
3	GDL	34 (modified k = 12.8 cm/sec)
4	40 mil LLDPE geomembrane Pinhole Density = 0 holes/ac Installation defects = 0 defects/ac Placement quality = 1, perfect	36
5	12* inches Final cover	6

Note: The Help modeling was performed with a final cover thickness of 12 inches. Actual final cover thickness is designed at 24 inches. As a result the HELP post closure predictions are slightly higher than what would be expected with the 24 inch thick final cover.

c. Design: The following design features were incorporated into the model.

Summary of Other Design Data	
Description	**Value**
Hydrologic Soil Group	B
Runoff Curve Number	86 – Active 69 - Closed
Fraction of Area Allowing Runoff	First Lift – 0% Mid-Fill – 50% Full-Fill – 75% Closed Fill – 100%
Evaporative Zone Depth	9 in
Maximum Leaf Area Index	0
Start of Growing Season	Day 102
End of Growing Season	Day 300
Average Wind Speed	9.3 mph
Average Humidity	62% - 71%

5. Summary of Modeling

The attached Table B summarizes the peak unit leachate flows for the active landfill periods of First Lift, mid-Fill, and Full-Fill. Table B(a) Summarizes the peak average unit leachate flow in units of (in/ac)/month. These values are taken directly from the HELP modeling output. The month with the greatest leachate flow was chosen for this table.

Table B(b) converts this data to units of (in/ac)/day by dividing the Table B(a) values by 30. Table B(c) converts the Table B(b) data to units of (cf/ac)/day. Note 1"/ac = 3,630 cf/ac. Table B(d) provides a comparison with the peak daily unit leachate flows in units of (cf/ac)/day. This data is also taken directly from the HELP modeling output. Specific Table B(d) values are used for design since they are greater than the Table B(c) values.

From this data, the following specific Table B(d) values were selected for design.

Active Landfill Unit Leachate Flows (cf/ac)/day		
Lift Condition	**Floor**	**Sideslope**
First Lift	1,300	1,655
Mid-Fill	1,011	1,001
Full-Fill	1,113	1,031

Attached Tables C through L provide similar data for the post-closure years 1 through 10. From this data, the following specific values were selected for design.

Closed Landfill Unit Leachate Flows Full-Fill (cf/ac)/day		
Year	**Floor**	**Sideslope**
1	521	486
2	16	16
3	3	3
4	2	2
5	1	1
6	1	1
7	0	0
8	0	0
9	0	0
10	0	0

6. Calculations

The active and closed unit flows were multiplied by cell acres for the various fill conditions and floor or sideslope areas, and converted to gal. Cell 1 has the greatest peak daily flow of 132,216 gal. Cell 5F has the least peak daily flow of 16,877 gal. The following table summarizes these calculations.

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Summary of Peak Daily Leachate Generation for each Cell

Cell	Area of Floor (acre)	Area of Slope (acre)	Peak Daily Leachate (gal/day)	Peak Daily Leachate (gal/min)
1	11.7	1.5	132,340	19.9
2	5.4	2.1	78,506	54.5
3	4.2	0.7	49,506	34.4
4	4.9	0.6	55,075	38.2
5A	4.7	0.9	56,844	39.5
5B	2.9	0.5	34,389	23.9
5C	3.6	.8	45,405	31.5
5D	1.9	1.0	30,855	21.4
5E	2.3	0.9	33,507	23.3
5F	1.0	0.7	28,340	12.8
6	2.0	3.2	58,788	40.8
7	2.2	4.5	76,826	53.4
8	4.6	1.4	62,327	43.3
9	2.7	1.3	42,348	29.4
10	7.5	2.1	98,193	68.2
11	3.9	3.1	76,963	53.4
12	5.7	1.0	67,806	47.1
13	2.6	0.8	35,186	24.4
14	4.0	0.3	42,609	29.6
15	2.8	1.9	50,748	35.2
16	2.1	2.4	50,131	34.8

7. Conclusion(s)

Based on the foregoing, the estimated leachate flows for each cell by fill condition can be used to develop a timeline of potential peak daily leachate flows for the facility based on the cell life values. Additionally, this data can be used to size pumps and force main.

8. References

1. Schroeder, Paul R., et al; *"The Hydrologic Evaluation of landfill Performance (HELP) Model"*; U.S. Environmental protection Agency; Version 3.

2. Project Design Information.

3. Related Project Design Calculations.

4. *"Climate for Baltimore, Maryland"*; http:/www.rssweather,com; Average Temperatures and Rainfall; 01/20/2020.

5. *"Point Precipitation Frequency Estimates"*; NOAA Atlas 14, Volume 2, Version 3, 2018.

6. *"Urban Hydrology for Small Watersheds"*; Technical Release 55 (TR-55); US Dept. of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division; June 1986.

Table A - Cell Life Estimates

Cell	*Total Cell Area (ac)*	*Avg. Top of Waste Elevation (ft)*	*Avg. Top of LCL Elevation (ft)*	*Avg. Waste Thickness (ft)*	*Avg. Number of 8-ft Lifts (ea)*	*HELP [2] Number of 8-ft Lifts (ea)*	*Estimated Cell Life [3] (months)*	*Cell Life [4] (months)*
1	13.2	236	120	116	14.5	15	24.2	24
2	7.5	184	104	80	10.0	10	8.4	8
3	4.9	206	113	93	11.6	12	5.4	5
4	5.5	170	117	53	6.6	7	4.3	4
5A	5.6	220	126	94	11.8	12	7.7	8
5B	3.4	208	128	80	10.0	10	3.6	4
5C	4.4	194	130	64	8.0	8	4.2	4
5D	2.9	186	130	56	7.0	7	2.1	2
5E	3.2	172	129	43	5.4	5	2.3	2
5F	1.7	172	128	44	5.5	6	1.6	2
6	5.2	220	118	102	12.8	13	9.7	10
7	6.7	230	112	118	14.8	15	11.8	12
8	6	220	120	100	12.5	13	9.2	9
9	4	220	120	100	12.5	13	5.7	6
10	9.6	236	122	114	14.3	14	14.8	15
11	7	144	84	60	7.5	8	7.9	8
12	6.7	140	87	53	6.6	7	5.0	5
13	3.4	138	87	51	6.4	6	2.9	3
14	4.3	156	89	67	8.4	8	3.5	4
15	4.7	166	91	75	9.4	9	4.7	5
16	4.5	178	90	88	11.0	11	5.5	6
Total	114.4					*Total Months*	144.5	144.0
						Total Years	12.0	12.0

Table B - Unit Leachate Flows for Active Landfill

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	3.9646	3.9762	3.9061	3.8971	3.9324	5.0931
			Mid-Fill			
20	3.9096	3.8765	3.9012	3.8921	3.8917	4.1508
32	3.9895	3.9579	5.0739	3.9747	3.9817	4.2507
52	4.2913	4.2622	4.2675	4.2878	4.2894	4.5609
68	4.5604	4.5358	4.5527	4.5454	4.5562	4.5609
			Full-Fill			
40	4.9051	4.9167	4.8789	4.8825	4.8052	4.6126
64	4.8495	4.8600	4.8580	4.8608	4.7205	3.0332
104	4.2406	4.2719	4.2472	4.2562	3.9390	3.8179
136	3.7138	3.7049	3.6791	3.6822	3.9749	4.4312

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	0.1322	0.1325	0.1302	0.1299	0.1311	0.1698
			Mid-Fill			
20	0.1303	0.1292	0.1300	0.1297	0.1297	0.1384
32	0.1330	0.1319	0.1691	0.1325	0.1327	0.1417
52	0.1430	0.1421	0.1423	0.1429	0.1430	0.1520
68	0.1520	0.1512	0.1518	0.1515	0.1519	0.1520
			Full-Fill			
40	0.1635	0.1639	0.1626	0.1628	0.1602	0.1538
64	0.1617	0.1620	0.1619	0.1620	0.1574	0.1011
104	0.1414	0.1424	0.1416	0.1419	0.1313	0.1273
136	0.1238	0.1235	0.1226	0.1227	0.1325	0.1477

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	480	481	473	472	476	616
			Mid-Fill			
20	473	469	472	471	471	502
32	483	479	614	481	482	514
52	519	516	516	519	519	552
68	552	549	551	550	551	552
			Full-Fill			
40	594	595	590	591	581	558
64	587	588	588	588	571	367
104	513	517	514	515	477	462
136	449	448	445	446	481	536

Total Waste Thickness (ft)	Peak Unit Leachate Flow - (cf/ac)/day (d)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	1100	1224	1300 ✓	1300	1214	1655 ✓
			Mid-Fill			
20	788	793	802	785	836	1001
32	839	832	1011 ✓	837	854	1001 ✓
52	883	924	838	864	841	1001
68	885	921	832	843	842	1001
			Full-Fill			
40	1031	1070	1028	1028	1096	977
64	963	978	975	980	944	1031 ✓
104	1058	1062	1113 ✓	1110	933	1024
136	1012	1022	1030	1027	985	993

Table C - Closed Landfill Year 1

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	2.0601	2.0771	1.8408	1.8450	1.9747	3.8101
64	3.2090	3.2387	3.3047	3.3121	3.0468	2.8131
104	3.1961	3.8942	3.8415	3.8314	4.0152	4.0198
136	4.2577	4.2622	4.2852	4.3087	4.1621	3.9763

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0687	0.0692	0.0614	0.0615	0.0658	0.1270
64	0.1070	0.1080	0.1102	0.1104	0.1016	0.0938
104	0.1065	0.1298	0.1281	0.1277	0.1338	0.1340
136	0.1419	0.1421	0.1428	0.1436	0.1387	0.1325

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	249	251	223	223	239	461
64	388	392	400	401	369	340
104	387	471	465	464	486	486 ✓
136	515	516	519	521 ✓	504	481

Table D - Closed Landfill Year 2

Total Waste Thickness (ft)	*Peak Avg. Unit Leachate Flow - (in/ac)/month (a)*					
	Leachate Collection System Drainage Slope (%)					
	2	*3*	*4*	*5*	*6*	*33*
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.1239	0.1237	0.1283	0.1283	0.1292	0.1316
64	0.1245	0.1243	0.1288	0.1288	0.1298	0.1324
104	0.1255	0.1253	0.1295	0.1295	0.1306	0.1328
136	0.1260	0.1258	0.1256	0.1299	0.1311	0.1336

Total Waste Thickness (ft)	*Peak Avg. Unit Leachate Flow - (in/ac)/day (b)*					
	Leachate Collection System Drainage Slope (%)					
	2	*3*	*4*	*5*	*6*	*33*
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0041	0.0041	0.0043	0.0043	0.0043	0.0044
64	0.0042	0.0041	0.0043	0.0043	0.0043	0.0044
104	0.0042	0.0042	0.0043	0.0043	0.0044	0.0044
136	0.0042	0.0042	0.0042	0.0043	0.0044	0.0045

Total Waste Thickness (ft)	*Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)*					
	Leachate Collection System Drainage Slope (%)					
	2	*3*	*4*	*5*	*6*	*33*
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	15	15	16	16	16	16
64	15	15	16	16	16	16
104	15	15	16 ✓	16	16	16 ✓
136	15	15	15	16	16	16

Table E - Closed Landfill Year 3

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0234	0.0234	0.0236	0.0236	0.0237	0.0238
64	0.0235	0.0235	0.0237	0.0237	0.0237	0.0238
104	0.0235	0.0235	0.0237	0.0237	0.0237	0.0238
136	0.0235	0.0235	0.0235	0.0237	0.0238	0.0239

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
64	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
104	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
136	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	3	3	3	3	3	3
64	3	3	3 ✓	3	3	3 ✓
104	3	3	3	3	3	3
136	3	3	3	3	3	3

Table F - Closed Landfill Year 4

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0129	0.0138	0.0134	0.0134	0.0133	0.0131
64	0.0137	0.0137	0.0133	0.0133	0.0132	0.0131
104	0.0136	0.0136	0.0133	0.0133	0.0132	0.0132
136	0.0136	0.0136	0.0136	0.0132	0.0131	0.0132

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0004	0.0005	0.0004	0.0004	0.0004	0.0004
64	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004
104	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004
136	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	2	2	2	2	2	2
64	2	2	2 ✓	2	2	2 ✓
104	2	2	2	2	2	2
136	2	2	2	2	2	2

Table G - Closed Landfill Year 5

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0090	0.0090	0.0091	0.0091	0.0091	0.0091
64	0.0090	0.0090	0.0091	0.0091	0.0091	0.0091
104	0.0090	0.0090	0.0091	0.0091	0.0091	0.0091
136	0.0091	0.0090	0.0090	0.0091	0.0091	0.0092

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
64	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
104	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
136	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	1	1	1	1	1	1
64	1	1	1 ✓	1	1	1 ✓
104	1	1	1	1	1	1
136	1	1	1	1	1	1

Table H - Closed Landfill Year 6

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0051	0.0051	0.0052	0.0052	0.0052	0.0052
64	0.0051	0.0051	0.0052	0.0052	0.0052	0.0052
104	0.0051	0.0051	0.0052	0.0052	0.0052	0.0052
136	0.0051	0.0051	0.0051	0.0052	0.0052	0.0052

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
64	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
104	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
136	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	1	1	1	1	1	1
64	1	1	1 ✓	1	1	1 ✓
104	1	1	1	1	1	1
136	1	1	1	1	1	1

Table I - Closed Landfill Year 7

Total Waste Thickness (ft)	*Peak Avg. Unit Leachate Flow - (in/ac)/month (a)*					
	Leachate Collection System Drainage Slope (%)					
	2	*3*	*4*	*5*	*6*	*33*
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	*Peak Avg. Unit Leachate Flow - (in/ac)/day (b)*					
	Leachate Collection System Drainage Slope (%)					
	2	*3*	*4*	*5*	*6*	*33*
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	*Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)*					
	Leachate Collection System Drainage Slope (%)					
	2	*3*	*4*	*5*	*6*	*33*
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0	0	0	0	0	0
64	0	0	0 ✓	0	0	0 ✓
104	0	0	0	0	0	0
136	0	0	0	0	0	0

Table J - Closed Landfill Year 8

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0	0	0	0	0	0
64	0	0	0 ✓	0	0	0 ✓
104	0	0	0	0	0	0
136	0	0	0	0	0	0

Table K - Closed Landfill Year 9

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
First Lift						
8	--	--	--	--	--	--
Mid-Fill						
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
Full-Fill						
40	0	0	0	0	0	0
64	0	0	0 ✓	0	0	0 ✓
104	0	0	0	0	0	0
136	0	0	0	0	0	0

Table L - Closed Landfill Year 10

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/month (a)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (in/ac)/day (b)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Total Waste Thickness (ft)	Peak Avg. Unit Leachate Flow - (cf/ac)/day (c)					
	Leachate Collection System Drainage Slope (%)					
	2	3	4	5	6	33
			First Lift			
8	--	--	--	--	--	--
			Mid-Fill			
20	--	--	--	--	--	--
32	--	--	--	--	--	--
52	--	--	--	--	--	--
68	--	--	--	--	--	--
			Full-Fill			
40	0	0	0	0	0	0
64	0	0	0 ✓	0	0	0 ✓
104	0	0	0	0	0	0
136	0	0	0	0	0	0

REFERENCE 1 pg 1/2

TABLE 4. DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0x10^{-2}
2	S	SW	0.437	0.062	0.024	5.8x10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1x10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7x10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0x10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2x10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2x10^{-4}
8	L	ML	0.463	0.232	0.116	3.7x10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9x10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2x10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4x10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2x10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3x10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5x10^{-5}
15	C	CH	0.475	0.378	0.265	1.7x10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0x10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0x10^{-9}
18	Municipal Waste (900 lb/yd^3 or 312 kg/m^3)		0.671	0.292	0.077	1.0x10^{-3}
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0x10^{-3}
20	Drainage Net (0.5 cm)		0.850	0.010	0.005	1.0x10^{+1}
21	Gravel		0.397	0.032	0.013	3.0x10^{-1}
22	L*	ML	0.419	0.307	0.180	1.9x10^{-5}
23	SiL*	ML	0.461	0.360	0.203	9.0x10^{-6}
24	SCL*	SC	0.365	0.305	0.202	2.7x10^{-6}
25	CL*	CL	0.437	0.373	0.266	3.6x10^{-6}
26	SiCL*	CL	0.445	0.393	0.277	1.9x10^{-6}
27	SC*	SC	0.400	0.366	0.288	7.8x10^{-7}
28	SiC*	CH	0.452	0.411	0.311	1.2x10^{-6}
29	C*	CH	0.451	0.419	0.332	6.8x10^{-7}
30	Coal-Burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0x10^{-5}
31	Coal-Burning Electric Plant Bottom Ash*		0.578	0.076	0.025	4.1x10^{-3}
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0x10^{-2}
33	Fine Copper Slag*		0.375	0.055	0.020	4.1x10^{-2}
34	Drainage Net (0.6 cm)		0.850	0.010	0.005	3.3x10^{+1}

* Moderately Compacted (Continued)

REFERENCE 1 Pg 2/2

TABLE 4 (continued). DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification		Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	Geomembrane Material	vol/vol	vol/vol	vol/vol	cm/sec
35	High Density Polyethylene (HDPE)				$2.0x10^{-13}$
36	Low Density Polyethylene (LDPE)				$4.0x10^{-13}$
37	Polyvinyl Chloride (PVC)				$2.0x10^{-11}$
38	Butyl Rubber				$1.0x10^{-12}$
39	Chlorinated Polyethylene (CPE)				$4.0x10^{-12}$
40	Hypalon or Chlorosulfonated Polyethylene (CSPE)				$3.0x10^{-12}$
41	Ethylene-Propylene Diene Monomer (EPDM)				$2.0x10^{-12}$
42	Neoprene				$3.0x10^{-12}$

(concluded)

user-defined soil option accepts non-default soil characteristics for layers assigned soil type numbers greater than 42. This is especially convenient for specifying characteristics of waste layers. User-specified soil characteristics can be assigned any soil type number greater than 42.

When a default soil type is used to describe the top soil layer, the program adjusts the saturated hydraulic conductivities of the soils in the top half of the evaporative zone for the effects of root channels. The saturated hydraulic conductivity value is multiplied by an empirical factor that is computed as a function of the user-specified maximum leaf area index. Example values of this factor are 1.0 for a maximum LAI of 0 (bare ground), 1.8 for a maximum LAI of 1 (poor stand of grass), 3.0 for a maximum LAI of 2 (fair stand of grass), 4.2 for a maximum LAI of 3.3 (good stand of grass) and 5.0 for a maximum LAI of 5 (excellent stand of grass).

The manual option requires values for porosity, field capacity, wilting point, and saturated hydraulic conductivity. These and related soil properties are defined below.

Soil Water Storage (Volumetric Content): the ratio of the volume of water in a soil to the total volume occupied by the soil, water and voids.

Total Porosity: the soil water storage/volumetric content at saturation (fraction of total volume).

REFERENCE 4

134/1

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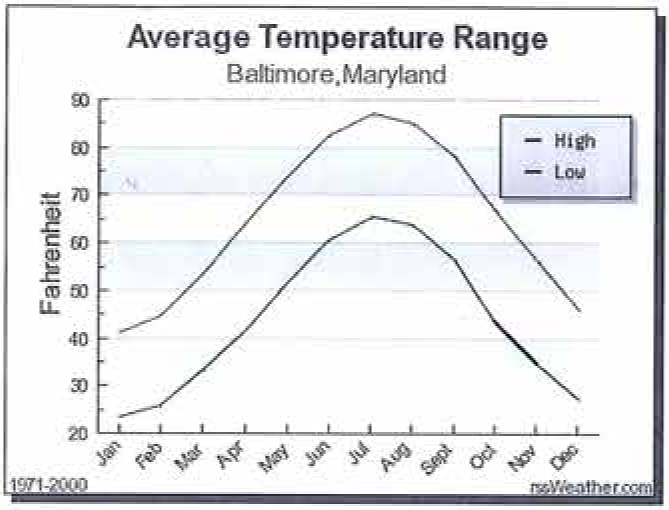
Average Temperatures for Baltimore

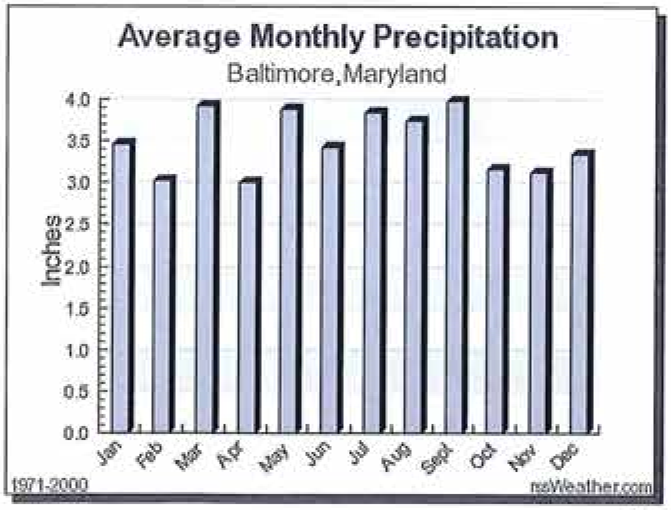


(°F)

Month	Low	High	AVG
Jan	23.5°F	41.2°F	32,4
Feb	26.1°F	44.8°F	35,5
Mar	33.6°F	53.9°F	43,7
Apr	42.0°F	64.5°F	53,2
May	51.8°F	73.9°F	62,8
Jun	60.8°F	82.7°F	71,7
Jul	65.8°F	87.2°F	76,5
Aug	63.9°F	85.1°F	74,5
Sept	56.6°F	78.2°F	67,4
Oct	43.7°F	67.0°F	55,3
Nov	34.7°F	56.3°F	45,5
Dec	27.3°F	46.0°F	36,6

Baltimore's coldest month is January when the average temperature overnight is 23.5°F. In July, the warmest month, the average day temperature rises to 87.2°F.

Average Rainfall for Baltimore



Month	Precipitation
Jan	3.47in.
Feb	3.02in.
Mar	3.93in.
Apr	3.00in.
May	3.89in.
Jun	3.43in.
Jul	3.85in.
Aug	3.74in.
Sept	3.98in.
Oct	3.16in.
Nov	3.12in.
Dec	3.35in.

Total : 41,94"

The driest month in Baltimore is April with 3.00 inches of precipitation, and with 3.98 inches September is the wettest month.

REFERENCE 5
PG 1/1.

NOAA Atlas 14, Volume 2, Version 3
Location name: Odenton, Maryland, USA*
Latitude: 39.0489°, Longitude: -76.7288°
Elevation: 65.46 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.347 (0.315-0.382)	0.415 (0.376-0.457)	0.494 (0.447-0.544)	0.551 (0.498-0.607)	0.623 (0.559-0.687)	0.677 (0.605-0.747)	0.729 (0.649-0.807)	0.779 (0.689-0.867)	0.842 (0.736-0.943)	0.891 (0.773-1.00)
10-min	0.554 (0.503-0.610)	0.664 (0.602-0.730)	0.791 (0.716-0.871)	0.882 (0.797-0.971)	0.993 (0.892-1.10)	1.08 (0.963-1.19)	1.16 (1.03-1.28)	1.24 (1.09-1.37)	1.33 (1.17-1.49)	1.40 (1.22-1.58)
15-min	0.693 (0.629-0.763)	0.834 (0.756-0.918)	1.00 (0.906-1.10)	1.12 (1.01-1.23)	1.26 (1.13-1.39)	1.37 (1.22-1.51)	1.47 (1.30-1.62)	1.56 (1.38-1.73)	1.68 (1.47-1.88)	1.76 (1.53-1.98)
30-min	0.950 (0.862-1.05)	1.15 (1.05-1.27)	1.42 (1.29-1.57)	1.62 (1.46-1.78)	1.87 (1.67-2.06)	2.06 (1.84-2.27)	2.24 (2.00-2.48)	2.43 (2.15-2.70)	2.67 (2.33-2.99)	2.85 (2.47-3.21)
60-min	1.18 (1.08-1.30)	1.45 (1.31-1.59)	1.82 (1.65-2.01)	2.10 (1.90-2.32)	2.48 (2.23-2.74)	2.79 (2.49-3.08)	3.09 (2.75-3.42)	3.40 (3.01-3.78)	3.83 (3.35-4.29)	4.16 (3.61-4.69)
2-hr	1.40 (1.27-1.55)	1.71 (1.55-1.88)	2.16 (1.96-2.38)	2.51 (2.27-2.76)	3.01 (2.70-3.31)	3.41 (3.05-3.75)	3.83 (3.40-4.22)	4.26 (3.76-4.72)	4.88 (4.25-5.45)	5.38 (4.64-6.04)
3-hr	1.52 (1.38-1.67)	1.84 (1.67-2.03)	2.34 (2.12-2.58)	2.73 (2.46-3.00)	3.28 (2.94-3.62)	3.74 (3.33-4.13)	4.22 (3.73-4.67)	4.74 (4.14-5.26)	5.47 (4.72-6.11)	6.07 (5.17-6.82)
6-hr	1.87 (1.71-2.07)	2.27 (2.06-2.50)	2.86 (2.60-3.16)	3.35 (3.03-3.70)	4.08 (3.65-4.50)	4.70 (4.16-5.19)	5.36 (4.71-5.95)	6.09 (5.29-6.77)	7.16 (6.10-8.03)	8.06 (6.77-9.10)
12-hr	2.27 (2.05-2.55)	2.75 (2.48-3.09)	3.50 (3.14-3.93)	4.14 (3.69-4.64)	5.12 (4.52-5.73)	5.98 (5.22-6.70)	6.93 (5.98-7.79)	8.00 (6.81-9.03)	9.64 (8.01-10.9)	11.1 (9.02-12.6)
24-hr	2.64 (2.41-2.93)	3.20 (2.91-3.55)	4.11 (3.74-4.56)	4.92 (4.45-5.44)	6.16 (5.53-6.76)	7.26 (6.46-7.94)	8.50 (7.49-9.27)	9.91 (8.64-10.8)	12.1 (10.4-13.1)	14.0 (11.8-15.1)
2-day	3.06 (2.78-3.38)	3.71 (3.37-4.10)	4.76 (4.32-5.26)	5.66 (5.12-6.24)	7.02 (6.31-7.72)	8.21 (7.33-9.00)	9.53 (8.44-10.4)	11.0 (9.65-12.1)	13.2 (11.4-14.5)	15.2 (12.9-16.6)
3-day	3.23 (2.94-3.56)	3.90 (3.56-4.31)	5.00 (4.56-5.52)	5.95 (5.40-6.54)	7.36 (6.64-8.08)	8.60 (7.70-9.41)	9.97 (8.86-10.9)	11.5 (10.1-12.6)	13.8 (12.0-15.1)	15.8 (13.5-17.3)
4-day	3.39 (3.10-3.74)	4.10 (3.75-4.52)	5.25 (4.79-5.78)	6.23 (5.67-6.84)	7.70 (6.96-8.44)	8.99 (8.07-9.82)	10.4 (9.28-11.4)	12.0 (10.6-13.1)	14.4 (12.5-15.7)	16.4 (14.1-18.0)
7-day	3.94 (3.61-4.32)	4.74 (4.35-5.20)	5.99 (5.48-6.57)	7.06 (6.45-7.73)	8.66 (7.86-9.45)	10.0 (9.06-10.9)	11.6 (10.4-12.6)	13.2 (11.8-14.4)	15.8 (13.8-17.2)	17.9 (15.5-19.5)
10-day	4.48 (4.13-4.89)	5.39 (4.96-5.87)	6.73 (6.19-7.32)	7.84 (7.20-8.53)	9.47 (8.65-10.3)	10.8 (9.85-11.7)	12.3 (11.1-13.3)	13.9 (12.5-15.1)	16.2 (14.4-17.6)	18.2 (16.0-19.8)
20-day	6.05 (5.62-6.52)	7.19 (6.68-7.75)	8.69 (8.07-9.37)	9.91 (9.18-10.7)	11.6 (10.7-12.5)	13.0 (11.9-14.0)	14.4 (13.2-15.5)	15.9 (14.5-17.1)	17.9 (16.2-19.3)	19.6 (17.6-21.1)
30-day	7.47 (6.97-8.01)	8.84 (8.25-9.48)	10.5 (9.81-11.3)	11.9 (11.0-12.7)	13.7 (12.7-14.7)	15.2 (14.1-16.3)	16.7 (15.4-17.9)	18.2 (16.7-19.5)	20.4 (18.5-21.8)	22.0 (19.9-23.7)
45-day	9.40 (8.82-10.0)	11.1 (10.4-11.8)	13.0 (12.2-13.8)	14.4 (13.5-15.3)	16.3 (15.2-17.3)	17.7 (16.6-18.9)	19.2 (17.9-20.4)	20.6 (19.1-21.9)	22.4 (20.7-23.9)	23.7 (21.8-25.3)
60-day	11.2 (10.5-11.9)	13.2 (12.4-14.0)	15.2 (14.3-16.1)	16.8 (15.8-17.7)	18.8 (17.6-19.9)	20.2 (19.0-21.4)	21.7 (20.3-23.0)	23.0 (21.5-24.4)	24.7 (23.0-26.3)	26.0 (24.1-27.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information. —— 2018*

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REFERENCE 6 Pg 1/3

Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred (Brakensiek and Rawls 1983).

HSG	*Soil textures*
A	Sand, loamy sand, or sandy loam
B	Silt loam or loam
C	Sandy clay loam
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay

Drainage and group D soils

Some soils in the list are in group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in a different group. For example, Ackerman soil is classified as A/D. This indicates that the drained Ackerman soil is in group A and the undrained soil is in group D.

REFERENCE 6 pg 2/3

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2/]	A	B	C	D
Fully developed urban areas (vegetation established)			closed		
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

---

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

REFERENCE 6 pg 3/3

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

bare soil

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

ATTACHMENT 10A

Leachate Generation Rates (per acre)

Reviewed by PGS 08/29/2021

HELP MODEL PRINTOUTS

FIRST LIFT

Floor slope 2%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\L1 S2.OUT


TIME:  10:22     DATE:   6/24/2020


******************************************************************************

     TITLE:  LIFT 1, S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2146 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =    96.00   INCHES
           POROSITY                   =     0.1680 VOL/VOL
           FIELD CAPACITY             =     0.0730 VOL/VOL
           WILTING POINT              =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.0752 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    48.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2857 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =    24.00   INCHES
           POROSITY                   =     0.4570 VOL/VOL
           FIELD CAPACITY             =     0.1310 VOL/VOL
           WILTING POINT              =     0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2681 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  5
                                   --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =     0.15   INCHES
           POROSITY                   =     0.8500 VOL/VOL
           FIELD CAPACITY             =     0.0100 VOL/VOL
           WILTING POINT              =     0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.7418 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
           SLOPE                      =     2.00   PERCENT
```

```
      DRAINAGE LENGTH              =    250.0    FEET


                        LAYER  6
                        --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
      THICKNESS                  =      0.06   INCHES
      POROSITY                   =      0.0000 VOL/VOL
      FIELD CAPACITY             =      0.0000 VOL/VOL
      WILTING POINT              =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
      FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
      FML PLACEMENT QUALITY       =  1 - PERFECT




              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.829  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     30.054  INCHES
   TOTAL INITIAL WATER                =     30.054  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
```

```
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND
               AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                 MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                 JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                 ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.000
                                  0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION                1.675   1.864   2.700   2.247   1.954   4.920
                                  1.901   3.316   1.120   3.010   2.304   1.282

LATERAL DRAINAGE COLLECTED        3.9506  1.1506  0.5951  0.5382  0.3354  0.2925
  FROM LAYER  5                   0.3398  0.2785  0.2241  3.9646  1.6774  2.3662
```

```
PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  6                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.064   0.021   0.010   0.009   0.005   0.005
  TOP OF LAYER  6                0.005   0.004   0.004   0.511   0.028   0.626

STD. DEVIATION OF DAILY          0.035   0.004   0.002   0.002   0.002   0.001
  HEAD ON TOP OF LAYER  6        0.001   0.001   0.001   1.435   0.008   1.657

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                         44.01          159756.297    100.00

  RUNOFF                                 0.000              0.000      0.00

  EVAPOTRANSPIRATION                    28.293         102702.633     64.29

  DRAINAGE COLLECTED FROM LAYER  5      15.7129         57037.941     35.70

  PERC./LEAKAGE THROUGH LAYER  6         0.000006           0.023      0.00

  AVG. HEAD ON TOP OF LAYER  6           0.1076

  CHANGE IN WATER STORAGE                0.004             15.703      0.01

  SOIL WATER AT START OF YEAR           30.055         109099.852

  SOIL WATER AT END OF YEAR             30.059         109115.555

  SNOW WATER AT START OF YEAR            0.000              0.000      0.00

  SNOW WATER AT END OF YEAR              0.000              0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000            -0.006      0.00

*******************************************************************************




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```

```
            AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.675    1.864    2.700    2.247    1.954    4.920
                           1.901    3.316    1.120    3.010    2.304    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 LATERAL DRAINAGE COLLECTED FROM LAYER  5
 ----------------------------------------
   TOTALS                  3.9506   1.1506   0.5951   0.5382   0.3354   0.2925
                           0.3398   0.2785   0.2241   3.9646   1.6774   2.3662

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  6
 -------------------------------------
   AVERAGES                0.0636   0.0205   0.0096   0.0090   0.0054   0.0049
                           0.0055   0.0045   0.0037   0.5113   0.0279   0.6257

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
******************************************************************************


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES           CU. FEET       PERCENT
                               -------------------  -------------   ---------
 PRECIPITATION                 44.01    (   0.000)    159756.3     100.00

 RUNOFF                          0.000   (  0.0000)         0.00      0.000

 EVAPOTRANSPIRATION             28.293   (  0.0000)    102702.63     64.287

 LATERAL DRAINAGE COLLECTED     15.71293 (  0.00000)     57037.941   35.70309
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH     0.00001 (  0.00000)         0.023     0.00001
   LAYER  6

 AVERAGE HEAD ON TOP             0.108 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE         0.004   (  0.0000)        15.70      0.010

******************************************************************************




******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                                    (INCHES)      (CU. FT.)
                                                   ----------   -------------
      PRECIPITATION                                  6.16         22360.799

      RUNOFF                                         0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5               0.30316       1100.45642

      PERCOLATION/LEAKAGE THROUGH LAYER  6           0.000001          0.00241

      AVERAGE HEAD ON TOP OF LAYER  6                5.845

      MAXIMUM HEAD ON TOP OF LAYER  6                8.948

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                   58.6 FEET

      SNOW WATER                                     0.77          2798.9209
```

```
          MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

          MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850

     ***  Maximum heads are computed using McEnroe's equations.  ***

          Reference:  Maximum Saturated Depth over Landfill Liner
                      by Bruce M. McEnroe, University of Kansas
                      ASCE Journal of Environmental Engineering
                      Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************




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                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.5774         0.2148

                  2            7.2211         0.0752

                  3           13.7150         0.2857

                  4            6.4331         0.2680

                  5            0.1113         0.7418

                  6            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

FIRST LIFT

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\L1 S3.OUT


TIME:  10:30     DATE:   6/24/2020


******************************************************************************

     TITLE:  LIFT 1, S = 3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2146 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2680 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4882 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
SLOPE                       =      3.00   PERCENT
DRAINAGE LENGTH             =    250.0    FEET
```

```
                        LAYER  6
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  1 - PERFECT


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER            =     86.00
FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      1.829  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =     30.013  INCHES
TOTAL INITIAL WATER                =     30.013  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

     STATION LATITUDE                        =  39.18 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   0.00
     START OF GROWING SEASON (JULIAN DATE)   =    102
     END OF GROWING SEASON (JULIAN DATE)     =    300
     EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
```

```
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        3.47        3.02        3.93        3.00        3.89        3.43
        3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       32.40       35.50       43.70       53.20       62.80       71.70
       76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.000
                                 0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION               1.675   1.864   2.700   2.247   1.954   4.920
                                 1.901   3.316   1.120   3.010   2.304   1.282

LATERAL DRAINAGE COLLECTED      3.9178  1.1465  0.5932  0.5385  0.3341  0.2929
  FROM LAYER  5                 0.3400  0.2774  0.2251  3.9762  1.6694  2.4020

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
  LAYER  6                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.042   0.014   0.006   0.006   0.004   0.003
  TOP OF LAYER  6                 0.004   0.003   0.002   0.043   0.019   0.026

STD. DEVIATION OF DAILY           0.024   0.002   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  6         0.000   0.001   0.001   0.029   0.005   0.034

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                             INCHES          CU. FEET     PERCENT
                                            --------        ----------    -------
  PRECIPITATION                               44.01         159756.297    100.00

  RUNOFF                                      0.000              0.000      0.00

  EVAPOTRANSPIRATION                         28.293         102702.633     64.29

  DRAINAGE COLLECTED FROM LAYER  5          15.7130          57038.230     35.70

  PERC./LEAKAGE THROUGH LAYER  6           0.000003              0.009      0.00

  AVG. HEAD ON TOP OF LAYER  6              0.0143

  CHANGE IN WATER STORAGE                     0.004             15.440      0.01

  SOIL WATER AT START OF YEAR                30.014         108950.914

  SOIL WATER AT END OF YEAR                  30.018         108966.359

  SNOW WATER AT START OF YEAR                 0.000              0.000      0.00

  SNOW WATER AT END OF YEAR                   0.000              0.000      0.00

  ANNUAL WATER BUDGET BALANCE                0.0000             -0.016      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
```

```
-------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                          2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                          0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

   STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                 1.675    1.864    2.700    2.247    1.954    4.920
                          1.901    3.316    1.120    3.010    2.304    1.282

   STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

 LATERAL DRAINAGE COLLECTED FROM LAYER  5
 ----------------------------------------
   TOTALS                 3.9178   1.1465   0.5932   0.5385   0.3341   0.2929
                          0.3400   0.2774   0.2251   3.9762   1.6694   2.4020

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  6
 -------------------------------------
   AVERAGES               0.0421   0.0136   0.0064   0.0060   0.0036   0.0033
                          0.0037   0.0030   0.0025   0.0427   0.0185   0.0258

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                    INCHES            CU. FEET       PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION             28.293   (  0.0000)     102702.63     64.287

 LATERAL DRAINAGE COLLECTED     15.71301 (  0.00000)     57038.230   35.70327
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  6

 AVERAGE HEAD ON TOP             0.014 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE         0.004   (  0.0000)         15.44      0.010

*******************************************************************************
```

```
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------    -------------
      PRECIPITATION                              6.16         22360.799

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5           0.33714       1223.81494

      PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000         0.00005

      AVERAGE HEAD ON TOP OF LAYER  6            0.112

      MAXIMUM HEAD ON TOP OF LAYER  6            0.222

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                2.8 FEET

      SNOW WATER                                 0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                     LAYER        (INCHES)       (VOL/VOL)
                     -----        --------       ---------
                       1           2.5774         0.2148

                       2           7.2211         0.0752

                       3          13.7150         0.2857

                       4           6.4301         0.2679

                       5           0.0732         0.4879

                       6           0.0000         0.0000

                   SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices

a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FIRST LIFT

Floor slope 4%

```
*****************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\L1 S4.OUT


TIME:  10:34     DATE:   6/24/2020


******************************************************************************

     TITLE:  LIFT 1, S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2162 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
        THICKNESS                  =     96.00   INCHES
        POROSITY                   =      0.1680 VOL/VOL
        FIELD CAPACITY             =      0.0730 VOL/VOL
        WILTING POINT              =      0.0190 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
        THICKNESS                  =     48.00   INCHES
        POROSITY                   =      0.4530 VOL/VOL
        FIELD CAPACITY             =      0.1900 VOL/VOL
        WILTING POINT              =      0.0850 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
        THICKNESS                  =     24.00   INCHES
        POROSITY                   =      0.4570 VOL/VOL
        FIELD CAPACITY             =      0.1310 VOL/VOL
        WILTING POINT              =      0.0580 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.2698 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
        THICKNESS                  =      0.15   INCHES
        POROSITY                   =      0.8500 VOL/VOL
        FIELD CAPACITY             =      0.0100 VOL/VOL
        WILTING POINT              =      0.0050 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.3845 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
        SLOPE                      =      4.00   PERCENT
        DRAINAGE LENGTH            =    250.0    FEET
```

```
                        LAYER  6
                        --------

                 TYPE 4 - FLEXIBLE MEMBRANE LINER
                   MATERIAL TEXTURE NUMBER  35
        THICKNESS                  =      0.06   INCHES
        POROSITY                   =      0.0000 VOL/VOL
        FIELD CAPACITY             =      0.0000 VOL/VOL
        WILTING POINT              =      0.0000 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
        FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
        FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
        FML PLACEMENT QUALITY      =  1 - PERFECT


               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ----------------------------------------

      NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

     SCS RUNOFF CURVE NUMBER             =     86.00
     FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE   =      1.847  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
     LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
     INITIAL SNOW WATER                  =      0.000  INCHES
     INITIAL WATER IN LAYER MATERIALS    =     30.035  INCHES
     TOTAL INITIAL WATER                 =     30.035  INCHES
     TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                EVAPOTRANSPIRATION AND WEATHER DATA
                -----------------------------------

      NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
               BALTIMORE             MARYLAND

          STATION LATITUDE                        =  39.18 DEGREES
          MAXIMUM LEAF AREA INDEX                 =   0.00
          START OF GROWING SEASON (JULIAN DATE)   =    102
          END OF GROWING SEASON (JULIAN DATE)     =    300
          EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
          AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
```

```
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        3.47        3.02        3.93        3.00        3.89        3.43
        3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       32.40       35.50       43.70       53.20       62.80       71.70
       76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                 MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.000
                                  0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION                1.684   1.880   2.770   2.254   1.951   4.906
                                  1.943   3.303   1.126   3.010   2.304   1.282

LATERAL DRAINAGE COLLECTED        3.9061  1.1604  0.5986  0.5331  0.3441  0.2903
  FROM LAYER  5                   0.3283  0.2594  0.2130  3.8189  1.7367  2.3797

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
  LAYER  6                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.031   0.010   0.005   0.004   0.003   0.002
  TOP OF LAYER  6                 0.003   0.002   0.002   0.031   0.014   0.019

STD. DEVIATION OF DAILY           0.018   0.002   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  6         0.000   0.001   0.001   0.021   0.004   0.025

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                            44.01         159756.297    100.00

  RUNOFF                                    0.000             0.000      0.00

  EVAPOTRANSPIRATION                       28.413        103139.414     64.56

  DRAINAGE COLLECTED FROM LAYER  5         15.5684        56513.383     35.37

  PERC./LEAKAGE THROUGH LAYER  6            0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  6              0.0106

  CHANGE IN WATER STORAGE                   0.029           103.488      0.06

  SOIL WATER AT START OF YEAR              30.037        109033.961

  SOIL WATER AT END OF YEAR                30.065        109137.445

  SNOW WATER AT START OF YEAR               0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                 0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE               0.0000            0.001      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
```

```
-------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                2.00     1.42     3.53     1.61     2.69     4.35
                          2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS       0.00     0.00     0.00     0.00     0.00     0.00
                          0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                1.684    1.880    2.770    2.254    1.951    4.906
                          1.943    3.303    1.126    3.010    2.304    1.282

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  5
  ----------------------------------------
    TOTALS                3.9061   1.1604   0.5986   0.5331   0.3441   0.2903
                          0.3283   0.2594   0.2130   3.8189   1.7367   2.3797

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  6
  -------------------------------------
    AVERAGES              0.0315   0.0104   0.0048   0.0044   0.0028   0.0024
                          0.0026   0.0021   0.0018   0.0308   0.0145   0.0192

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES           CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          0.000   (  0.0000)         0.00      0.000

 EVAPOTRANSPIRATION             28.413   (  0.0000)     103139.41     64.560

 LATERAL DRAINAGE COLLECTED     15.56843 (  0.00000)     56513.383   35.37474
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  6

 AVERAGE HEAD ON TOP             0.011 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE         0.029   (  0.0000)       103.49      0.065

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------    -------------
      PRECIPITATION                           6.16         22360.799

      RUNOFF                                  0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5        0.35806       1299.75378

      PERCOLATION/LEAKAGE THROUGH LAYER  6    0.000000         0.00004

      AVERAGE HEAD ON TOP OF LAYER  6         0.089

      MAXIMUM HEAD ON TOP OF LAYER  6         0.177

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)             2.3 FEET

      SNOW WATER                              0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1           2.5967         0.2164

                    2           7.2708         0.0757

                    3          13.6426         0.2842

                    4           6.4960         0.2707

                    5           0.0577         0.3847

                    6           0.0000         0.0000

                SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FIRST LIFT

Floor slope 5%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\L1 S5.OUT


TIME:  10:36     DATE:   6/24/2020


******************************************************************************

     TITLE:  LIFT 1, S = 5%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2162 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
    THICKNESS                  =     96.00   INCHES
    POROSITY                   =      0.1680 VOL/VOL
    FIELD CAPACITY             =      0.0730 VOL/VOL
    WILTING POINT              =      0.0190 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  3
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
    THICKNESS                  =     48.00   INCHES
    POROSITY                   =      0.4530 VOL/VOL
    FIELD CAPACITY             =      0.1900 VOL/VOL
    WILTING POINT              =      0.0850 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC



                        LAYER  4
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
    THICKNESS                  =     24.00   INCHES
    POROSITY                   =      0.4570 VOL/VOL
    FIELD CAPACITY             =      0.1310 VOL/VOL
    WILTING POINT              =      0.0580 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2698 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  5
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
    THICKNESS                  =      0.15   INCHES
    POROSITY                   =      0.8500 VOL/VOL
    FIELD CAPACITY             =      0.0100 VOL/VOL
    WILTING POINT              =      0.0050 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.3086 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
    SLOPE                      =      5.00   PERCENT
    DRAINAGE LENGTH            =    250.0    FEET
```

```
                        LAYER  6
                        --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
    THICKNESS                  =      0.06   INCHES
    POROSITY                   =      0.0000 VOL/VOL
    FIELD CAPACITY             =      0.0000 VOL/VOL
    WILTING POINT              =      0.0000 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
    FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
    FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
    FML PLACEMENT QUALITY      =  1 - PERFECT



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

 SCS RUNOFF CURVE NUMBER            =     86.00
 FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =      1.847  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
 INITIAL SNOW WATER                 =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =     30.024  INCHES
 TOTAL INITIAL WATER                =     30.024  INCHES
 TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           BALTIMORE             MARYLAND

      STATION LATITUDE                        =  39.18 DEGREES
      MAXIMUM LEAF AREA INDEX                 =   0.00
      START OF GROWING SEASON (JULIAN DATE)   =    102
      END OF GROWING SEASON (JULIAN DATE)     =    300
      EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
      AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
      AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
      AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
      AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
```

```
         AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


     NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BALTIMORE           MARYLAND

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

   JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
   -------     -------     -------     -------     -------     -------
     3.47        3.02        3.93        3.00        3.89        3.43
     3.85        3.74        3.98        3.16        3.12        3.35


     NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BALTIMORE           MARYLAND

         NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

   JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
   -------     -------     -------     -------     -------     -------
    32.40       35.50       43.70       53.20       62.80       71.70
    76.50       74.50       67.40       55.30       45.50       36.60


     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BALTIMORE           MARYLAND
                AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

              MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.000
                                  0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION                1.684   1.880   2.770   2.254   1.951   4.906
                                  1.943   3.303   1.126   3.010   2.304   1.282

LATERAL DRAINAGE COLLECTED        3.8971  1.1591  0.5980  0.5332  0.3438  0.2903
  FROM LAYER  5                   0.3283  0.2591  0.2133  3.8225  1.7341  2.3894

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
  LAYER  6                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.025   0.008   0.004   0.004   0.002   0.002
  TOP OF LAYER  6                 0.002   0.002   0.001   0.025   0.012   0.015

STD. DEVIATION OF DAILY           0.014   0.001   0.001   0.001   0.000   0.000
  HEAD ON TOP OF LAYER  6         0.000   0.000   0.000   0.017   0.004   0.020

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
                                         --------       ----------    -------
  PRECIPITATION                            44.01        159756.297    100.00

  RUNOFF                                    0.000            0.000      0.00

  EVAPOTRANSPIRATION                       28.413       103139.414     64.56

  DRAINAGE COLLECTED FROM LAYER  5         15.5684       56513.332     35.37

  PERC./LEAKAGE THROUGH LAYER  6            0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  6              0.0085

  CHANGE IN WATER STORAGE                   0.029          103.544      0.06

  SOIL WATER AT START OF YEAR              30.026       108992.641

  SOIL WATER AT END OF YEAR                30.054       109096.180

  SNOW WATER AT START OF YEAR               0.000            0.000      0.00

  SNOW WATER AT END OF YEAR                 0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE               0.0000          -0.002      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
```

```
-------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                2.00     1.42     3.53     1.61     2.69     4.35
                          2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS       0.00     0.00     0.00     0.00     0.00     0.00
                          0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                1.684    1.880    2.770    2.254    1.951    4.906
                          1.943    3.303    1.126    3.010    2.304    1.282

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  5
  ----------------------------------------
    TOTALS                3.8971   1.1591   0.5980   0.5332   0.3438   0.2903
                          0.3283   0.2591   0.2133   3.8225   1.7341   2.3894

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  6
  -------------------------------------
    AVERAGES              0.0251   0.0083   0.0039   0.0036   0.0022   0.0019
                          0.0021   0.0017   0.0014   0.0247   0.0116   0.0154

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                        INCHES            CU. FEET      PERCENT
                               -------------------    -------------   ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION              28.413   (  0.0000)     103139.41     64.560

 LATERAL DRAINAGE COLLECTED      15.56841 (  0.00000)     56513.332   35.37471
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.009    0.00001
   LAYER  6

 AVERAGE HEAD ON TOP              0.008 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE          0.029   (  0.0000)        103.54      0.065

*******************************************************************************
```

```
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                           6.16        22360.799

      RUNOFF                                  0.000           0.0000

      DRAINAGE COLLECTED FROM LAYER  5        0.35803      1299.65283

      PERCOLATION/LEAKAGE THROUGH LAYER  6    0.000000        0.00003

      AVERAGE HEAD ON TOP OF LAYER  6         0.072

      MAXIMUM HEAD ON TOP OF LAYER  6         0.143

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)             0.0 FEET

      SNOW WATER                              0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
   ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1            2.5967         0.2164

                 2            7.2708         0.0757

                 3           13.6426         0.2842

                 4            6.4960         0.2707

                 5            0.0463         0.3089

                 6            0.0000         0.0000

             SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices

a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FIRST LIFT

Floor slope 6%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\L1 S6.OUT


TIME:  10:38     DATE:   6/24/2020


******************************************************************************

     TITLE:  LIFT 1, S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00    INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2184 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                         LAYER  2
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
   THICKNESS                   =     96.00   INCHES
   POROSITY                    =      0.1680 VOL/VOL
   FIELD CAPACITY              =      0.0730 VOL/VOL
   WILTING POINT               =      0.0190 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0764 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                         LAYER  3
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
   THICKNESS                   =     48.00   INCHES
   POROSITY                    =      0.4530 VOL/VOL
   FIELD CAPACITY              =      0.1900 VOL/VOL
   WILTING POINT               =      0.0850 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.2834 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC



                         LAYER  4
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
   THICKNESS                   =     24.00   INCHES
   POROSITY                    =      0.4570 VOL/VOL
   FIELD CAPACITY              =      0.1310 VOL/VOL
   WILTING POINT               =      0.0580 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.2706 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                         LAYER  5
                         --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.15   INCHES
   POROSITY                    =      0.8500 VOL/VOL
   FIELD CAPACITY              =      0.0100 VOL/VOL
   WILTING POINT               =      0.0050 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.2643 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
   SLOPE                       =      6.00   PERCENT
   DRAINAGE LENGTH             =    250.0    FEET
```

```
                         LAYER  6
                         --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER              =     86.00
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =      9.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      1.866  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.077  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.765  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     30.092  INCHES
TOTAL INITIAL WATER                  =     30.092  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

     STATION LATITUDE                     =  39.18 DEGREES
     MAXIMUM LEAF AREA INDEX              =   0.00
     START OF GROWING SEASON (JULIAN DATE) =   102
     END OF GROWING SEASON (JULIAN DATE)   =   300
     EVAPORATIVE ZONE DEPTH               =   9.0  INCHES
     AVERAGE ANNUAL WIND SPEED            =   9.30 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
```

```
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
      3.47        3.02        3.93        3.00        3.89        3.43
      3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     32.40       35.50       43.70       53.20       62.80       71.70
     76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.000
                                  0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION                1.685   1.892   2.770   2.245   1.962   4.882
                                  1.941   3.322   1.128   3.025   2.301   1.281

LATERAL DRAINAGE COLLECTED        3.9324  1.1691  0.6030  0.5437  0.3435  0.2874
  FROM LAYER  5                   0.3235  0.2682  0.2070  3.7555  1.7751  2.3821

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
  LAYER  6                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.021   0.007   0.003   0.003   0.002   0.002
  TOP OF LAYER  6                 0.002   0.001   0.001   0.020   0.010   0.013

STD. DEVIATION OF DAILY           0.012   0.001   0.001   0.001   0.000   0.000
  HEAD ON TOP OF LAYER  6         0.000   0.000   0.000   0.014   0.003   0.017

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                           INCHES          CU. FEET     PERCENT
                                          --------        ----------    -------
  PRECIPITATION                             44.01         159756.297    100.00

  RUNOFF                                     0.000             0.000      0.00

  EVAPOTRANSPIRATION                        28.434        103214.734     64.61

  DRAINAGE COLLECTED FROM LAYER  5          15.5903        56592.941     35.42

  PERC./LEAKAGE THROUGH LAYER  6             0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  6               0.0071

  CHANGE IN WATER STORAGE                   -0.014           -51.436     -0.03

  SOIL WATER AT START OF YEAR               30.094        109240.766

  SOIL WATER AT END OF YEAR                 30.080        109189.336

  SNOW WATER AT START OF YEAR                0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                  0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE                0.0000            0.043      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
```

```
-------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                2.00     1.42     3.53     1.61     2.69     4.35
                          2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS       0.00     0.00     0.00     0.00     0.00     0.00
                          0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                1.685    1.892    2.770    2.245    1.962    4.882
                          1.941    3.322    1.128    3.025    2.301    1.281

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  5
  ----------------------------------------
    TOTALS                3.9324   1.1691   0.6030   0.5437   0.3435   0.2874
                          0.3235   0.2682   0.2070   3.7555   1.7751   2.3821

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  6
  -------------------------------------
    AVERAGES              0.0212   0.0070   0.0032   0.0030   0.0018   0.0016
                          0.0017   0.0014   0.0012   0.0202   0.0099   0.0128

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
*******************************************************************************


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES            CU. FEET     PERCENT
                               -------------------   -------------  ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION             28.434   (  0.0000)     103214.73     64.608

 LATERAL DRAINAGE COLLECTED     15.59034 (  0.00000)     56592.941   35.42455
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  6

 AVERAGE HEAD ON TOP             0.007 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE        -0.014   (  0.0000)        -51.44     -0.032

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------    -------------
      PRECIPITATION                           6.16         22360.799

      RUNOFF                                  0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5        0.33446       1214.10095

      PERCOLATION/LEAKAGE THROUGH LAYER  6    0.000000         0.00003

      AVERAGE HEAD ON TOP OF LAYER  6         0.056

      MAXIMUM HEAD ON TOP OF LAYER  6         0.110

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)             3.9 FEET

      SNOW WATER                              0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

```
******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.6235         0.2186

                  2            7.3349         0.0764

                  3           13.5910         0.2831

                  4            6.4897         0.2704

                  5            0.0392         0.2611

                  6            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

FIRST LIFT

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                  **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\L1S33.OUT


TIME:   9:12     DATE:   6/26/2020


******************************************************************************

     TITLE:  FIRST LIFT 8 FT; S=33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2834 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC



                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2706 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  5
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2643 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
SLOPE                      =     33.00   PERCENT
DRAINAGE LENGTH            =     75.0    FEET
```

```
                        LAYER  6
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER            =     86.00
FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =     29.977  INCHES
TOTAL INITIAL WATER                =     29.977  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR



            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

     STATION LATITUDE                        =  39.18 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   0.00
     START OF GROWING SEASON (JULIAN DATE)   =    102
     END OF GROWING SEASON (JULIAN DATE)     =    300
     EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
```

```
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.000
                                 0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION               1.824   1.867   2.419   2.046   1.775   4.580
                                 1.625   3.255   0.866   3.028   2.137   1.277

LATERAL DRAINAGE COLLECTED       3.7862  1.0902  0.5624  0.4940  0.3539  0.4715
  FROM LAYER  5                  0.4345  0.2208  0.2850  5.0931  1.8656  2.2461

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
  LAYER  6                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.001   0.000   0.000   0.000   0.000   0.000
  TOP OF LAYER  6                0.000   0.000   0.000   0.002   0.001   0.001

STD. DEVIATION OF DAILY          0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  6        0.000   0.000   0.000   0.001   0.000   0.001

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                          44.01         159756.297     100.00

  RUNOFF                                  0.000             0.000       0.00

  EVAPOTRANSPIRATION                     26.699         96915.625      60.66

  DRAINAGE COLLECTED FROM LAYER  5       16.9035        61359.539      38.41

  PERC./LEAKAGE THROUGH LAYER  6          0.000002          0.009       0.00

  AVG. HEAD ON TOP OF LAYER  6            0.0005

  CHANGE IN WATER STORAGE                 0.408          1481.120       0.93

  SOIL WATER AT START OF YEAR            30.017        108961.148

  SOIL WATER AT END OF YEAR              30.425        110442.266

  SNOW WATER AT START OF YEAR             0.000             0.000       0.00

  SNOW WATER AT END OF YEAR               0.000             0.000       0.00

  ANNUAL WATER BUDGET BALANCE             0.0000            0.005       0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
```

```
-------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                2.00     1.42     3.53     1.61     2.69     4.35
                          2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS       0.00     0.00     0.00     0.00     0.00     0.00
                          0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                1.824    1.867    2.419    2.046    1.775    4.580
                          1.625    3.255    0.866    3.028    2.137    1.277

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  5
  ----------------------------------------
    TOTALS                3.7862   1.0902   0.5624   0.4940   0.3539   0.4715
                          0.4345   0.2208   0.2850   5.0931   1.8656   2.2461

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  6
  -------------------------------------
    AVERAGES              0.0012   0.0004   0.0002   0.0002   0.0001   0.0002
                          0.0001   0.0001   0.0001   0.0017   0.0006   0.0007

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
*******************************************************************************


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                                -------------------  -------------  ---------
 PRECIPITATION                     44.01    (   0.000)     159756.3     100.00

 RUNOFF                             0.000   (  0.0000)          0.00     0.000

 EVAPOTRANSPIRATION                26.699   (  0.0000)      96915.62    60.665

 LATERAL DRAINAGE COLLECTED        16.90345 (  0.00000)     61359.539   38.40821
   FROM LAYER  5

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)         0.009    0.00001
   LAYER  6

 AVERAGE HEAD ON TOP                0.000 (    0.000)
   OF LAYER  6

 CHANGE IN WATER STORAGE            0.408   (  0.0000)       1481.12     0.927

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------    -------------
      PRECIPITATION                              6.16         22360.799

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  5           0.45608       1655.55908

      PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  6            0.005

      MAXIMUM HEAD ON TOP OF LAYER  6            0.037

      LOCATION OF MAXIMUM HEAD IN LAYER  5
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3855

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                 FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1           2.6653         0.2221

                   2           7.5117         0.0782

                   3          13.5059         0.2814

                   4           6.6983         0.2791

                   5           0.0040         0.0269

                   6           0.0000         0.0000

               SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 2.5 LIFTS

Floor slope 2%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF2-5S2.OUT


TIME:  12: 8     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 2.5 LIFTS, S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                         TYPE 1 - VERTICAL PERCOLATION LAYER
                             MATERIAL TEXTURE NUMBER   6
           THICKNESS                     =     12.00   INCHES
           POROSITY                      =      0.4530 VOL/VOL
           FIELD CAPACITY                =      0.1900 VOL/VOL
           WILTING POINT                 =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    144.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC



                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                  =     24.00   INCHES
  POROSITY                   =      0.4570 VOL/VOL
  FIELD CAPACITY             =      0.1310 VOL/VOL
  WILTING POINT              =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.2680 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                  =      0.15   INCHES
  POROSITY                   =      0.8500 VOL/VOL
  FIELD CAPACITY             =      0.0100 VOL/VOL
  WILTING POINT              =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.7418 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
  SLOPE                      =      2.00   PERCENT
  DRAINAGE LENGTH            =    250.0    FEET



                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                  =      0.06   INCHES
  POROSITY                   =      0.0000 VOL/VOL
  FIELD CAPACITY             =      0.0000 VOL/VOL
  WILTING POINT              =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY      =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
     SCS RUNOFF CURVE NUMBER             =     86.00
     FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
     LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
     INITIAL SNOW WATER                  =      0.000  INCHES
     INITIAL WATER IN LAYER MATERIALS    =     43.518  INCHES
     TOTAL INITIAL WATER                 =     43.518  INCHES
     TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

      NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
               BALTIMORE             MARYLAND

          STATION LATITUDE                         =  39.18 DEGREES
          MAXIMUM LEAF AREA INDEX                  =   0.00
          START OF GROWING SEASON (JULIAN DATE)    =    102
          END OF GROWING SEASON (JULIAN DATE)      =    300
          EVAPORATIVE ZONE DEPTH                   =   9.0  INCHES
          AVERAGE ANNUAL WIND SPEED                =   9.30 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  68.00 %


      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    3.47        3.02        3.93        3.00        3.89        3.43
    3.85        3.74        3.98        3.16        3.12        3.35


      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   32.40       35.50       43.70       53.20       62.80       71.70
   76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                  2.00    1.42    3.53    1.61    2.69    4.35
                               2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                         0.000   0.000   0.000   0.000   0.000   0.010
                               0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION             1.811   1.893   2.700   2.247   1.953   4.921
                               1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED     3.9096  1.1403  0.7120  0.4506  0.5215  0.2855
  FROM LAYER  7                0.2769  0.3636  0.2172  1.2992  2.1901  1.0233

PERCOLATION/LEAKAGE THROUGH    0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON          0.063   0.020   0.011   0.007   0.008   0.005
  TOP OF LAYER  8              0.004   0.006   0.004   0.021   0.036   0.016

STD. DEVIATION OF DAILY        0.027   0.004   0.003   0.002   0.002   0.001
  HEAD ON TOP OF LAYER  8      0.001   0.000   0.001   0.028   0.013   0.007

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES         CU. FEET     PERCENT
                                       --------       ----------    -------
  PRECIPITATION                          44.01        159756.297    100.00

  RUNOFF                                  2.022         7340.542      4.59
```

```
 EVAPOTRANSPIRATION                   28.415       103145.367     64.56

 DRAINAGE COLLECTED FROM LAYER  7     12.3899       44975.187     28.15

 PERC./LEAKAGE THROUGH LAYER  8        0.000003         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8          0.0169

 CHANGE IN WATER STORAGE               1.183         4295.227      2.69

 SOIL WATER AT START OF YEAR          43.629       158372.875

 SOIL WATER AT END OF YEAR            44.812       162668.094

 SNOW WATER AT START OF YEAR           0.000            0.000      0.00

 SNOW WATER AT END OF YEAR             0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE           0.0000          -0.039      0.00

*******************************************************************************




*******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                  3.9096   1.1403   0.7120   0.4506   0.5215   0.2855
                            0.2769   0.3636   0.2172   1.2992   2.1901   1.0233

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES                0.0629   0.0203   0.0115   0.0075   0.0084   0.0047
                            0.0045   0.0059   0.0036   0.0209   0.0364   0.0165

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                        INCHES            CU. FEET     PERCENT
                                  -------------------  -------------  ---------
 PRECIPITATION                       44.01    (   0.000)    159756.3    100.00

 RUNOFF                               2.022   (  0.0000)      7340.54     4.595

 EVAPOTRANSPIRATION                  28.415   (  0.0000)    103145.37    64.564

 LATERAL DRAINAGE COLLECTED          12.38986 (  0.00000)    44975.187   28.15237
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH          0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP                  0.017 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE              1.183   (  0.0000)      4295.23     2.689
*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
     PRECIPITATION                             6.16        22360.799

     RUNOFF                                    1.702        6179.5317

     DRAINAGE COLLECTED FROM LAYER  7          0.21716       788.30511

     PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000         0.00004

     AVERAGE HEAD ON TOP OF LAYER  8           0.108

     MAXIMUM HEAD ON TOP OF LAYER  8           0.213

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)               4.1 FEET

     SNOW WATER                                0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
               LAYER        (INCHES)        (VOL/VOL)
               -----        --------        ---------
                 1            2.5575          0.2131

                 2           11.0014          0.0764

                 3            3.5432          0.2953

                 4            7.3889          0.0770

                 5           14.0817          0.2934

                 6            6.1266          0.2553

                 7            0.0017          0.0110

                 8            0.0000          0.0000

             SNOW WATER       0.000

******************************************************************************
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```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 2.5 LIFTS

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF2-5S3.OUT


TIME:  12:15     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 2.5 LIFTS, S = 3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    144.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC



                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2679 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4879 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
SLOPE                       =      3.00   PERCENT
DRAINAGE LENGTH             =    250.0    FEET



                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  1 - PERFECT



                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     43.477  INCHES
   TOTAL INITIAL WATER                 =     43.477  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                      =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX               =   0.00
        START OF GROWING SEASON (JULIAN DATE) =    102
        END OF GROWING SEASON (JULIAN DATE)   =    300
        EVAPORATIVE ZONE DEPTH                =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED             =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.010
                                 0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION               1.811   1.893   2.700   2.247   1.953   4.921
                                 1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED      3.8765  1.1378  0.7091  0.4515  0.5203  0.2852
  FROM LAYER  7                 0.2770  0.3643  0.2162  1.3177  2.1762  1.0179

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.042   0.014   0.008   0.005   0.006   0.003
  TOP OF LAYER  8                0.003   0.004   0.002   0.014   0.024   0.011

STD. DEVIATION OF DAILY          0.018   0.003   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.001   0.019   0.009   0.005

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                            INCHES          CU. FEET     PERCENT
                                           --------        ----------    -------
  PRECIPITATION                              44.01         159756.297    100.00

  RUNOFF                                      2.022          7340.542      4.59
```

```
  EVAPOTRANSPIRATION                    28.415        103145.367     64.56

  DRAINAGE COLLECTED FROM LAYER  7      12.3495        44828.777     28.06

  PERC./LEAKAGE THROUGH LAYER  8         0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8           0.0113

  CHANGE IN WATER STORAGE                1.224          4441.648      2.78

  SOIL WATER AT START OF YEAR           43.550        158087.641

  SOIL WATER AT END OF YEAR             44.774        162529.297

  SNOW WATER AT START OF YEAR            0.000             0.000      0.00

  SNOW WATER AT END OF YEAR              0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000           -0.050      0.00

******************************************************************************




******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                            2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                            0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                            0.000    0.040    1.702    0.046    0.000    0.224

    STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                  1.811    1.893    2.700    2.247    1.953    4.921
                            1.729    3.442    1.119    3.011    2.305    1.282

    STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 3.8765   1.1378   0.7091   0.4515   0.5203   0.2852
                           0.2770   0.3643   0.2162   1.3177   2.1762   1.0179

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0416   0.0135   0.0076   0.0050   0.0056   0.0032
                           0.0030   0.0039   0.0024   0.0141   0.0241   0.0109

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                       INCHES             CU. FEET     PERCENT
                                 -------------------   -------------  ---------
 PRECIPITATION                     44.01    (   0.000)     159756.3    100.00

 RUNOFF                             2.022   (  0.0000)       7340.54     4.595

 EVAPOTRANSPIRATION                28.415   (  0.0000)     103145.37    64.564

 LATERAL DRAINAGE COLLECTED        12.34953 (  0.00000)     44828.777   28.06073
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP                0.011 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE            1.224   (  0.0000)       4441.65     2.780
******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                           (INCHES)      (CU. FT.)
                                          ----------    -------------
      PRECIPITATION                          6.16         22360.799

      RUNOFF                                 1.702         6179.5317

      DRAINAGE COLLECTED FROM LAYER  7       0.21851        793.19189

      PERCOLATION/LEAKAGE THROUGH LAYER  8   0.000000         0.00003

      AVERAGE HEAD ON TOP OF LAYER  8        0.073

      MAXIMUM HEAD ON TOP OF LAYER  8        0.144

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)            2.4 FEET

      SNOW WATER                             0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)              0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)              0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

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******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1            2.5575         0.2131

                   2           11.0014         0.0764

                   3            3.5432         0.2953

                   4            7.3889         0.0770

                   5           14.0817         0.2934

                   6            6.1266         0.2553

                   7            0.0015         0.0100

                   8            0.0000         0.0000

               SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 2.5 LIFTS

Floor slope 4%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF2-5S4.OUT


TIME:  12:18     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 2.5 LIFTS, S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                      =     12.00   INCHES
           POROSITY                       =      0.4530 VOL/VOL
           FIELD CAPACITY                 =      0.1900 VOL/VOL
           WILTING POINT                  =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT     =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.      =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  2
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    144.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  3
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2164 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                       LAYER  4
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  5
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2707 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  7
                       --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3847 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
SLOPE                      =      4.00   PERCENT
DRAINAGE LENGTH            =    250.0    FEET


                       LAYER  8
                       --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
      SCS RUNOFF CURVE NUMBER            =     86.00
      FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
      EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
      INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
      UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
      LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
      INITIAL SNOW WATER                 =      0.000  INCHES
      INITIAL WATER IN LAYER MATERIALS   =     43.524  INCHES
      TOTAL INITIAL WATER                =     43.524  INCHES
      TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


                  EVAPOTRANSPIRATION AND WEATHER DATA
                  -----------------------------------

       NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                BALTIMORE             MARYLAND

           STATION LATITUDE                      =  39.18 DEGREES
           MAXIMUM LEAF AREA INDEX               =   0.00
           START OF GROWING SEASON (JULIAN DATE) =    102
           END OF GROWING SEASON (JULIAN DATE)   =    300
           EVAPORATIVE ZONE DEPTH                =   9.0  INCHES
           AVERAGE ANNUAL WIND SPEED             =   9.30 MPH
           AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  62.00 %
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  65.00 %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  71.00 %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  68.00 %


       NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
      3.47        3.02        3.93        3.00        3.89        3.43
      3.85        3.74        3.98        3.16        3.12        3.35


       NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND

            NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     32.40       35.50       43.70       53.20       62.80       71.70
     76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                               JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                               ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.010
                                 0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION               1.805   1.879   2.771   2.254   1.951   4.910
                                 1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED       3.9012  1.1466  0.7137  0.4618  0.5032  0.3054
  FROM LAYER  7                  0.2817  0.3397  0.2222  0.9906  2.3483  1.0461

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.031   0.010   0.006   0.004   0.004   0.003
  TOP OF LAYER  8                0.002   0.003   0.002   0.008   0.020   0.008

STD. DEVIATION OF DAILY          0.013   0.002   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.011   0.007   0.003

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                            INCHES         CU. FEET     PERCENT
                                           --------       ----------    -------
  PRECIPITATION                              44.01        159756.297    100.00

  RUNOFF                                      2.038         7397.054      4.63
```

```
  EVAPOTRANSPIRATION                  28.531       103566.992     64.83

  DRAINAGE COLLECTED FROM LAYER  7    12.2605       44505.512     27.86

  PERC./LEAKAGE THROUGH LAYER  8       0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8         0.0084

  CHANGE IN WATER STORAGE              1.181         4286.642      2.68

  SOIL WATER AT START OF YEAR         43.582       158201.812

  SOIL WATER AT END OF YEAR           44.763       162488.453

  SNOW WATER AT START OF YEAR          0.000            0.000      0.00

  SNOW WATER AT END OF YEAR            0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE          0.0000           0.088      0.00

*******************************************************************************




*******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.043    1.705    0.045    0.000    0.233

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.879    2.771    2.254    1.951    4.910
                           1.762    3.475    1.126    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 3.9012   1.1466   0.7137   0.4618   0.5032   0.3054
                           0.2817   0.3397   0.2222   0.9906   2.3483   1.0461

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0314   0.0102   0.0058   0.0038   0.0041   0.0025
                           0.0023   0.0027   0.0019   0.0080   0.0196   0.0084

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES            CU. FEET     PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           2.038   (  0.0000)      7397.05      4.630

 EVAPOTRANSPIRATION              28.531   (  0.0000)    103566.99     64.828

 LATERAL DRAINAGE COLLECTED      12.26047 (  0.00000)    44505.512   27.85838
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.008 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          1.181   (  0.0000)      4286.64      2.683
*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------   -------------
     PRECIPITATION                              6.16         22360.799

     RUNOFF                                     1.705         6189.2476

     DRAINAGE COLLECTED FROM LAYER  7           0.22109        802.55194

     PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000         0.00003

     AVERAGE HEAD ON TOP OF LAYER  8            0.055

     MAXIMUM HEAD ON TOP OF LAYER  8            0.110

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)                0.5 FEET

     SNOW WATER                                 0.77          2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.6051         0.2171

                  2           10.9399         0.0760

                  3            3.5335         0.2945

                  4            7.4407         0.0775

                  5           14.0822         0.2934

                  6            6.1021         0.2543

                  7            0.0015         0.0101

                  8            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

MID-HEIGHT – 2.5 LIFTS

Floor slope 5%

```
*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************



PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF2-5S5.OUT


TIME:  12:22     DATE:   6/24/2020


*******************************************************************************

     TITLE:  MID FILL @ 2.5 LIFTS, S = 5%

*******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00    INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    144.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2164 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                    LAYER  4
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  5
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                    LAYER  6
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2707 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  7
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3089 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
SLOPE                      =      5.00   PERCENT
DRAINAGE LENGTH            =    250.0    FEET


                    LAYER  8
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT


        GENERAL DESIGN AND EVAPORATIVE ZONE DATA
        ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
     SCS RUNOFF CURVE NUMBER            =     86.00
     FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
     LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
     INITIAL SNOW WATER                 =      0.000  INCHES
     INITIAL WATER IN LAYER MATERIALS   =     43.513  INCHES
     TOTAL INITIAL WATER                =     43.513  INCHES
     TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

      NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
               BALTIMORE             MARYLAND

          STATION LATITUDE                     =  39.18 DEGREES
          MAXIMUM LEAF AREA INDEX              =   0.00
          START OF GROWING SEASON (JULIAN DATE)  =    102
          END OF GROWING SEASON (JULIAN DATE)    =    300
          EVAPORATIVE ZONE DEPTH               =   9.0  INCHES
          AVERAGE ANNUAL WIND SPEED            =   9.30 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE          MARYLAND

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

   JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
   -------     -------     -------     -------     -------     -------
     3.47        3.02        3.93        3.00        3.89        3.43
     3.85        3.74        3.98        3.16        3.12        3.35


      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE          MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

   JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
   -------     -------     -------     -------     -------     -------
    32.40       35.50       43.70       53.20       62.80       71.70
    76.50       74.50       67.40       55.30       45.50       36.60
```

```
          NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE          MARYLAND
                     AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.010
                                  0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION                1.805   1.879   2.771   2.254   1.951   4.910
                                  1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED        3.8921  1.1459  0.7130  0.4619  0.5028  0.3053
  FROM LAYER  7                   0.2817  0.3398  0.2220  0.9961  2.3442  1.0444

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

AVERAGE DAILY HEAD ON             0.025   0.008   0.005   0.003   0.003   0.002
  TOP OF LAYER  8                 0.002   0.002   0.001   0.006   0.016   0.007

STD. DEVIATION OF DAILY           0.010   0.002   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.009   0.006   0.003

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES        CU. FEET     PERCENT
                                         --------      ----------    -------
  PRECIPITATION                            44.01       159756.297    100.00

  RUNOFF                                    2.038        7397.054      4.63
```

```
 EVAPOTRANSPIRATION                   28.531       103566.992     64.83

 DRAINAGE COLLECTED FROM LAYER  7     12.2491       44464.262     27.83

 PERC./LEAKAGE THROUGH LAYER  8        0.000002         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8          0.0067

 CHANGE IN WATER STORAGE               1.192         4327.893      2.71

 SOIL WATER AT START OF YEAR          43.559       158119.266

 SOIL WATER AT END OF YEAR            44.751       162447.156

 SNOW WATER AT START OF YEAR           0.000            0.000      0.00

 SNOW WATER AT END OF YEAR             0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE           0.0000           0.085      0.00

*******************************************************************************




*******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.043    1.705    0.045    0.000    0.233

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.805    1.879    2.771    2.254    1.951    4.910
                           1.762    3.475    1.126    3.011    2.304    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                 3.8921   1.1459   0.7130   0.4619   0.5028   0.3053
                          0.2817   0.3398   0.2220   0.9961   2.3442   1.0444

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES               0.0251   0.0082   0.0046   0.0031   0.0032   0.0020
                          0.0018   0.0022   0.0015   0.0064   0.0156   0.0067

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES             CU. FEET     PERCENT
                               -------------------    -------------  ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          2.038   (  0.0000)       7397.05      4.630

 EVAPOTRANSPIRATION             28.531   (  0.0000)     103566.99     64.828

 LATERAL DRAINAGE COLLECTED     12.24911 (  0.00000)     44464.262   27.83256
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP             0.007 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         1.192   (  0.0000)       4327.89      2.709

*******************************************************************************
```

```
*******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                             6.16        22360.799

      RUNOFF                                    1.705        6189.2476

      DRAINAGE COLLECTED FROM LAYER  7          0.21628       785.11383

      PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  8           0.043

      MAXIMUM HEAD ON TOP OF LAYER  8           0.088

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)               0.0 FEET

      SNOW WATER                                0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
*******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)        (VOL/VOL)
                 -----        --------        ---------
                   1            2.6051          0.2171

                   2           10.9399          0.0760

                   3            3.5335          0.2945

                   4            7.4407          0.0775

                   5           14.0822          0.2934

                   6            6.1021          0.2543

                   7            0.0015          0.0100

                   8            0.0000          0.0000

               SNOW WATER       0.000

*******************************************************************************
*******************************************************************************
```

HELP MODEL PRINTOUTS

MID-HEIGHT – 2.5 LIFTS

Floor slope 6%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF2-5S6.OUT


TIME:  12:26     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 2.5 LIFTS, S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00    INCHES
           POROSITY                     =      0.4530  VOL/VOL
           FIELD CAPACITY               =      0.1900  VOL/VOL
           WILTING POINT                =      0.0850  VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160  VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    144.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2186 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0764 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2831 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                  =     24.00   INCHES
  POROSITY                   =      0.4570 VOL/VOL
  FIELD CAPACITY             =      0.1310 VOL/VOL
  WILTING POINT              =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2704 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                  =      0.15   INCHES
  POROSITY                   =      0.8500 VOL/VOL
  FIELD CAPACITY             =      0.0100 VOL/VOL
  WILTING POINT              =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2611 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
  SLOPE                      =      6.00   PERCENT
  DRAINAGE LENGTH            =    250.0    FEET


                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                  =      0.06   INCHES
  POROSITY                   =      0.0000 VOL/VOL
  FIELD CAPACITY             =      0.0000 VOL/VOL
  WILTING POINT              =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY      =  1 - PERFECT


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
      SCS RUNOFF CURVE NUMBER            =     86.00
      FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
      EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
      INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
      UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
      LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
      INITIAL SNOW WATER                 =      0.000  INCHES
      INITIAL WATER IN LAYER MATERIALS   =     43.539  INCHES
      TOTAL INITIAL WATER                =     43.539  INCHES
      TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


                  EVAPOTRANSPIRATION AND WEATHER DATA
                  -----------------------------------

       NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                BALTIMORE             MARYLAND

           STATION LATITUDE                     =  39.18 DEGREES
           MAXIMUM LEAF AREA INDEX              =   0.00
           START OF GROWING SEASON (JULIAN DATE)  =    102
           END OF GROWING SEASON (JULIAN DATE)    =    300
           EVAPORATIVE ZONE DEPTH               =   9.0  INCHES
           AVERAGE ANNUAL WIND SPEED            =   9.30 MPH
           AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


       NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
      3.47        3.02        3.93        3.00        3.89        3.43
      3.85        3.74        3.98        3.16        3.12        3.35


       NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND

           NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     32.40       35.50       43.70       53.20       62.80       71.70
     76.50       74.50       67.40       55.30       45.50       36.60
```

```
          NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE           MARYLAND
                     AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.010
                                  0.000   0.046   1.706   0.046   0.000   0.253

EVAPOTRANSPIRATION                1.804   1.891   2.770   2.246   1.962   4.890
                                  1.762   3.477   1.127   3.025   2.302   1.281

LATERAL DRAINAGE COLLECTED        3.8917  1.1609  0.7181  0.4645  0.5036  0.3023
  FROM LAYER  7                   0.2769  0.3473  0.2158  0.9383  2.3799  1.0664

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.021   0.007   0.004   0.003   0.003   0.002
  TOP OF LAYER  8                 0.001   0.002   0.001   0.005   0.013   0.006

STD. DEVIATION OF DAILY           0.008   0.001   0.001   0.001   0.000   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.007   0.005   0.002

*******************************************************************************


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                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                             INCHES         CU. FEET     PERCENT
                                            --------       ----------    -------
  PRECIPITATION                               44.01        159756.297    100.00

  RUNOFF                                       2.063         7488.505      4.69
```

```
 EVAPOTRANSPIRATION                  28.539       103595.297     64.85

 DRAINAGE COLLECTED FROM LAYER  7    12.2657       44524.312     27.87

 PERC./LEAKAGE THROUGH LAYER  8       0.000002         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8         0.0056

 CHANGE IN WATER STORAGE              1.143         4148.140      2.60

 SOIL WATER AT START OF YEAR         43.578       158189.187

 SOIL WATER AT END OF YEAR           44.721       162337.328

 SNOW WATER AT START OF YEAR          0.000            0.000      0.00

 SNOW WATER AT END OF YEAR            0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE          0.0000           0.033      0.00

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       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.046    1.706    0.046    0.000    0.253

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.804    1.891    2.770    2.246    1.962    4.890
                           1.762    3.477    1.127    3.025    2.302    1.281

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                 3.8917   1.1609   0.7181   0.4645   0.5036   0.3023
                          0.2769   0.3473   0.2158   0.9383   2.3799   1.0664

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES               0.0209   0.0069   0.0039   0.0026   0.0027   0.0017
                          0.0015   0.0019   0.0012   0.0051   0.0132   0.0057

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                   INCHES             CU. FEET       PERCENT
                             -------------------   -------------   ---------
 PRECIPITATION                 44.01    (   0.000)     159756.3     100.00

 RUNOFF                         2.063   (  0.0000)       7488.51      4.687

 EVAPOTRANSPIRATION            28.539   (  0.0000)     103595.30     64.846

 LATERAL DRAINAGE COLLECTED    12.26565 (  0.00000)     44524.312   27.87015
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH    0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP            0.006 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE        1.143   (  0.0000)       4148.14      2.597
******************************************************************************
```

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*******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                            (INCHES)      (CU. FT.)
                                           ----------   -------------
     PRECIPITATION                            6.16        22360.799

     RUNOFF                                   1.706        6193.2847

     DRAINAGE COLLECTED FROM LAYER  7         0.23045       836.54144

     PERCOLATION/LEAKAGE THROUGH LAYER  8     0.000000        0.00002

     AVERAGE HEAD ON TOP OF LAYER  8          0.038

     MAXIMUM HEAD ON TOP OF LAYER  8          0.075

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)              5.9 FEET

     SNOW WATER                               0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

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                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1           2.6243          0.2187

                    2          11.1493          0.0774

                    3           3.5579          0.2965

                    4           7.1679          0.0747

                    5          14.3057          0.2980

                    6           5.8752          0.2448

                    7           0.0015          0.0100

                    8           0.0000          0.0000

                SNOW WATER      0.000

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```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 2.5 LIFTS

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF2-5S33.OUT


TIME:  10: 3     DATE:   6/26/2020


******************************************************************************

     TITLE:  MID FILL @ 2.5 LIFTS; S = 33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                      =     12.00   INCHES
           POROSITY                       =      0.4530 VOL/VOL
           FIELD CAPACITY                 =      0.1900 VOL/VOL
           WILTING POINT                  =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT     =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.      =  0.720000011000E-03 CM/SEC
```

```
                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    144.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2221 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                    LAYER  4
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0782 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  5
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2814 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                    LAYER  6
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2791 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  7
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0269 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
SLOPE                      =     33.00   PERCENT
DRAINAGE LENGTH            =     75.0    FEET


                    LAYER  8
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT


            GENERAL DESIGN AND EVAPORATIVE ZONE DATA
            ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
     SCS RUNOFF CURVE NUMBER             =     86.00
     FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
     LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
     INITIAL SNOW WATER                  =      0.000  INCHES
     INITIAL WATER IN LAYER MATERIALS    =     43.846  INCHES
     TOTAL INITIAL WATER                 =     43.846  INCHES
     TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

      NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
               BALTIMORE            MARYLAND

          STATION LATITUDE                       =  39.18 DEGREES
          MAXIMUM LEAF AREA INDEX                =   0.00
          START OF GROWING SEASON (JULIAN DATE)  =    102
          END OF GROWING SEASON (JULIAN DATE)    =    300
          EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
          AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    3.47        3.02        3.93        3.00        3.89        3.43
    3.85        3.74        3.98        3.16        3.12        3.35


      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   32.40       35.50       43.70       53.20       62.80       71.70
   76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.001   0.000   0.000   0.000   0.000   0.011
                                  0.000   0.055   1.652   0.046   0.002   0.332

EVAPOTRANSPIRATION                1.825   1.860   2.422   2.070   1.747   4.392
                                  1.480   3.464   0.920   3.065   2.340   1.287

LATERAL DRAINAGE COLLECTED        4.1508  1.1800  0.7543  0.4974  0.3264  0.4383
  FROM LAYER  7                   0.5095  0.2737  0.3501  2.3087  2.4550  1.0777

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

AVERAGE DAILY HEAD ON             0.001   0.000   0.000   0.000   0.000   0.000
  TOP OF LAYER  8                 0.000   0.000   0.000   0.001   0.001   0.000

STD. DEVIATION OF DAILY           0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.001   0.000   0.000

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET     PERCENT
                                       --------      ----------    -------
  PRECIPITATION                           44.01        159756.297   100.00

  RUNOFF                                   2.100         7622.630     4.77
```

```
 EVAPOTRANSPIRATION                    26.873        97548.234     61.06

 DRAINAGE COLLECTED FROM LAYER  7      14.3220       51988.867     32.54

 PERC./LEAKAGE THROUGH LAYER  8         0.000002         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8           0.0004

 CHANGE IN WATER STORAGE                0.715         2596.461      1.63

 SOIL WATER AT START OF YEAR           43.850       159175.625

 SOIL WATER AT END OF YEAR             44.565       161772.078

 SNOW WATER AT START OF YEAR            0.000            0.000      0.00

 SNOW WATER AT END OF YEAR              0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE            0.0000           0.093      0.00

*******************************************************************************




*******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.001    0.000    0.000    0.000    0.000    0.011
                           0.000    0.055    1.652    0.046    0.002    0.332

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.825    1.860    2.422    2.070    1.747    4.392
                           1.480    3.464    0.920    3.065    2.340    1.287

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                 4.1508   1.1800   0.7543   0.4974   0.3264   0.4383
                          0.5095   0.2737   0.3501   2.3087   2.4550   1.0777

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES               0.0013   0.0004   0.0002   0.0002   0.0001   0.0001
                          0.0002   0.0001   0.0001   0.0007   0.0008   0.0003

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                       INCHES            CU. FEET     PERCENT
                                 -------------------  -------------  ---------
 PRECIPITATION                     44.01    (   0.000)    159756.3    100.00

 RUNOFF                             2.100   (  0.0000)      7622.63     4.771

 EVAPOTRANSPIRATION                26.873   (  0.0000)     97548.23    61.061

 LATERAL DRAINAGE COLLECTED        14.32200 (  0.00000)    51988.867   32.54261
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP                0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE            0.715   (  0.0000)      2596.46     1.625

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```

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******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                            6.16        22360.799

      RUNOFF                                   1.652        5996.8691

      DRAINAGE COLLECTED FROM LAYER  7         0.27591      1001.54266

      PERCOLATION/LEAKAGE THROUGH LAYER  8     0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  8          0.003

      MAXIMUM HEAD ON TOP OF LAYER  8          0.005

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)              0.0 FEET

      SNOW WATER                               0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.3770

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1           2.6622         0.2218

                   2          11.2623         0.0782

                   3           3.5404         0.2950

                   4           7.2076         0.0751

                   5          14.3951         0.2999

                   6           5.4919         0.2288

                   7           0.0019         0.0125

                   8           0.0000         0.0000

               SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 4 LIFTS

Floor slope 2%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                        **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF4S2.OUT


TIME:  12:48     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 4 LIFTS, S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                 LAYER  1
                                 --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =    288.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     12.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2148 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =     96.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0752 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     48.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2857 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   5
     THICKNESS                  =     24.00   INCHES
     POROSITY                   =      0.4570 VOL/VOL
     FIELD CAPACITY             =      0.1310 VOL/VOL
     WILTING POINT              =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2680 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                   MATERIAL TEXTURE NUMBER   0
     THICKNESS                  =      0.15   INCHES
     POROSITY                   =      0.8500 VOL/VOL
     FIELD CAPACITY             =      0.0100 VOL/VOL
     WILTING POINT              =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.7418 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
     SLOPE                      =      2.00   PERCENT
     DRAINAGE LENGTH            =    250.0    FEET


                        LAYER  8
                        --------

                 TYPE 4 - FLEXIBLE MEMBRANE LINER
                   MATERIAL TEXTURE NUMBER  35
     THICKNESS                  =      0.06   INCHES
     POROSITY                   =      0.0000 VOL/VOL
     FIELD CAPACITY             =      0.0000 VOL/VOL
     WILTING POINT              =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
     FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
     FML PLACEMENT QUALITY      =  1 - PERFECT


             GENERAL DESIGN AND EVAPORATIVE ZONE DATA
             ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     54.390  INCHES
   TOTAL INITIAL WATER                =     54.390  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                       =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    102
        END OF GROWING SEASON (JULIAN DATE)    =    300
        EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                  2.00    1.42    3.53    1.61    2.69    4.35
                               2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                         0.000   0.000   0.000   0.000   0.000   0.010
                               0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION             1.811   1.893   2.700   2.247   1.953   4.921
                               1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED     3.9895  1.3185  0.7396  0.5050  0.5312  0.2895
  FROM LAYER  7                0.2806  0.3643  0.2171  1.1468  2.3268  1.0348

PERCOLATION/LEAKAGE THROUGH    0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON          0.064   0.024   0.012   0.008   0.009   0.005
  TOP OF LAYER  8              0.005   0.006   0.004   0.018   0.039   0.017

STD. DEVIATION OF DAILY        0.028   0.005   0.003   0.002   0.002   0.001
  HEAD ON TOP OF LAYER  8      0.001   0.000   0.001   0.032   0.015   0.005

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                          44.01         159756.297    100.00

  RUNOFF                                  2.022          7340.542      4.59
```

```
 EVAPOTRANSPIRATION                   28.415       103145.367     64.56

 DRAINAGE COLLECTED FROM LAYER  7     12.7438       46259.895     28.96

 PERC./LEAKAGE THROUGH LAYER  8        0.000003         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8          0.0174

 CHANGE IN WATER STORAGE               0.829         3010.469      1.88

 SOIL WATER AT START OF YEAR          54.501       197838.266

 SOIL WATER AT END OF YEAR            55.330       200848.734

 SNOW WATER AT START OF YEAR           0.000            0.000      0.00

 SNOW WATER AT END OF YEAR             0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE           0.0000           0.012      0.00

******************************************************************************




******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                  3.9895   1.3185   0.7396   0.5050   0.5312   0.2895
                           0.2806   0.3643   0.2171   1.1468   2.3268   1.0348

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES                0.0642   0.0235   0.0119   0.0084   0.0086   0.0048
                           0.0045   0.0059   0.0036   0.0185   0.0387   0.0167

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          2.022   (  0.0000)       7340.54      4.595

 EVAPOTRANSPIRATION             28.415   (  0.0000)     103145.37     64.564

 LATERAL DRAINAGE COLLECTED     12.74377 (  0.00000)     46259.895   28.95654
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP             0.017 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         0.829   (  0.0000)       3010.47      1.884
******************************************************************************
```

```
******************************************************************************

            PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
     PRECIPITATION                             6.16        22360.799

     RUNOFF                                    1.702        6179.5317

     DRAINAGE COLLECTED FROM LAYER  7          0.23105       838.70520

     PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000        0.00005

     AVERAGE HEAD ON TOP OF LAYER  8           0.115

     MAXIMUM HEAD ON TOP OF LAYER  8           0.226

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)               4.4 FEET

     SNOW WATER                                0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
              LAYER        (INCHES)       (VOL/VOL)
              -----        --------       ---------
                1            2.5575         0.2131

                2           22.0744         0.0766

                3            3.5137         0.2928

                4            7.3397         0.0765

                5           14.2005         0.2958

                6            5.5157         0.2298

                7            0.0175         0.1168

                8            0.0000         0.0000

            SNOW WATER       0.000

******************************************************************************
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```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 4 LIFTS

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF4S3.OUT


TIME:  12:52     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 4 LIFTS, S = 3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                     =     12.00   INCHES
           POROSITY                      =      0.4530 VOL/VOL
           FIELD CAPACITY                =      0.1900 VOL/VOL
           WILTING POINT                 =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    288.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                   =     24.00   INCHES
  POROSITY                    =      0.4570 VOL/VOL
  FIELD CAPACITY              =      0.1310 VOL/VOL
  WILTING POINT               =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2679 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =      0.15   INCHES
  POROSITY                    =      0.8500 VOL/VOL
  FIELD CAPACITY              =      0.0100 VOL/VOL
  WILTING POINT               =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.4879 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
  SLOPE                       =      3.00   PERCENT
  DRAINAGE LENGTH             =    250.0    FEET


                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =      0.06   INCHES
  POROSITY                    =      0.0000 VOL/VOL
  FIELD CAPACITY              =      0.0000 VOL/VOL
  WILTING POINT               =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY       =  1 - PERFECT


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     54.349  INCHES
   TOTAL INITIAL WATER                 =     54.349  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                   2.00    1.42    3.53    1.61    2.69    4.35
                                2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                          0.000   0.000   0.000   0.000   0.000   0.010
                                0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION              1.811   1.893   2.700   2.247   1.953   4.921
                                1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED      3.9579  1.3149  0.7365  0.5059  0.5298  0.2892
  FROM LAYER  7                 0.2807  0.3650  0.2161  1.1683  2.3100  1.0333

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.042   0.016   0.008   0.006   0.006   0.003
  TOP OF LAYER  8               0.003   0.004   0.002   0.013   0.026   0.011

STD. DEVIATION OF DAILY         0.019   0.003   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8       0.000   0.000   0.001   0.022   0.010   0.004

*******************************************************************************


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                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                            INCHES          CU. FEET     PERCENT
                                           --------        ----------    -------
  PRECIPITATION                              44.01         159756.297    100.00

  RUNOFF                                      2.022          7340.542      4.59
```

```
 EVAPOTRANSPIRATION                   28.415        103145.367     64.56

 DRAINAGE COLLECTED FROM LAYER  7     12.7076        46128.418     28.87

 PERC./LEAKAGE THROUGH LAYER  8        0.000002          0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8          0.0116

 CHANGE IN WATER STORAGE               0.866          3141.964      1.97

 SOIL WATER AT START OF YEAR          54.422        197553.047

 SOIL WATER AT END OF YEAR            55.288        200695.000

 SNOW WATER AT START OF YEAR           0.000             0.000      0.00

 SNOW WATER AT END OF YEAR             0.000             0.000      0.00

 ANNUAL WATER BUDGET BALANCE           0.0000           -0.005      0.00

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        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                  3.9579   1.3149   0.7365   0.5059   0.5298   0.2892
                           0.2807   0.3650   0.2161   1.1683   2.3100   1.0333

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES                0.0425   0.0156   0.0079   0.0056   0.0057   0.0032
                           0.0030   0.0039   0.0024   0.0125   0.0256   0.0111

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                     INCHES              CU. FEET     PERCENT
                               -------------------    -------------  ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           2.022   (  0.0000)       7340.54      4.595

 EVAPOTRANSPIRATION              28.415   (  0.0000)     103145.37     64.564

 LATERAL DRAINAGE COLLECTED      12.70755 (  0.00000)     46128.418   28.87424
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.012 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.866   (  0.0000)       3141.96      1.967

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             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                            (INCHES)      (CU. FT.)
                                           ----------   -------------
      PRECIPITATION                           6.16        22360.799

      RUNOFF                                  1.702        6179.5317

      DRAINAGE COLLECTED FROM LAYER  7        0.22910       831.61786

      PERCOLATION/LEAKAGE THROUGH LAYER  8    0.000000        0.00003

      AVERAGE HEAD ON TOP OF LAYER  8         0.076

      MAXIMUM HEAD ON TOP OF LAYER  8         0.151

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)             2.6 FEET

      SNOW WATER                              0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                   LAYER        (INCHES)        (VOL/VOL)
                   -----        --------        ---------
                     1            2.5575          0.2131

                     2           22.0744          0.0766

                     3            3.5137          0.2928

                     4            7.3397          0.0765

                     5           14.2005          0.2958

                     6            5.5157          0.2298

                     7            0.0133          0.0884

                     8            0.0000          0.0000

                  SNOW WATER      0.000

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ADVANCED GeoServices
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HELP MODEL PRINTOUTS

MID-HEIGHT – 4 LIFTS

Floor slope 4%

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF4S4.OUT


TIME:  12:55     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 4 LIFTS, S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                     =     12.00   INCHES
           POROSITY                      =      0.4530 VOL/VOL
           FIELD CAPACITY                =      0.1900 VOL/VOL
           WILTING POINT                 =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2171 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  2
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =    288.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0760 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  3
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     12.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2945 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                       LAYER  4
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =     96.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0775 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  5
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     48.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2934 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
     THICKNESS                  =     24.00   INCHES
     POROSITY                   =      0.4570 VOL/VOL
     FIELD CAPACITY             =      0.1310 VOL/VOL
     WILTING POINT              =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2543 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  7
                       --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                  =      0.15   INCHES
     POROSITY                   =      0.8500 VOL/VOL
     FIELD CAPACITY             =      0.0100 VOL/VOL
     WILTING POINT              =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0101 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
     SLOPE                      =      4.00   PERCENT
     DRAINAGE LENGTH            =    250.0    FEET


                       LAYER  8
                       --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
     THICKNESS                  =      0.06   INCHES
     POROSITY                   =      0.0000 VOL/VOL
     FIELD CAPACITY             =      0.0000 VOL/VOL
     WILTING POINT              =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
     FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
     FML PLACEMENT QUALITY      =  1 - PERFECT


            GENERAL DESIGN AND EVAPORATIVE ZONE DATA
            ----------------------------------------
```

```
          NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

         SCS RUNOFF CURVE NUMBER              =     86.00
         FRACTION OF AREA ALLOWING RUNOFF     =     50.0    PERCENT
         AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
         EVAPORATIVE ZONE DEPTH               =      9.0    INCHES
         INITIAL WATER IN EVAPORATIVE ZONE   =      1.954  INCHES
         UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
         LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
         INITIAL SNOW WATER                   =      0.000  INCHES
         INITIAL WATER IN LAYER MATERIALS    =     55.655  INCHES
         TOTAL INITIAL WATER                  =     55.655  INCHES
         TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR



                     EVAPOTRANSPIRATION AND WEATHER DATA
                     -----------------------------------

          NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                   BALTIMORE             MARYLAND

              STATION LATITUDE                       =  39.18 DEGREES
              MAXIMUM LEAF AREA INDEX                =   0.00
              START OF GROWING SEASON (JULIAN DATE)  =    102
              END OF GROWING SEASON (JULIAN DATE)    =    300
              EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
              AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
              AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
              AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
              AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
              AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


          NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE           MARYLAND

                   NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

        JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
        -------     -------     -------     -------     -------     -------
          3.47        3.02        3.93        3.00        3.89        3.43
          3.85        3.74        3.98        3.16        3.12        3.35


          NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE           MARYLAND

              NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

        JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
        -------     -------     -------     -------     -------     -------
         32.40       35.50       43.70       53.20       62.80       71.70
```

```
         76.50       74.50       67.40       55.30       45.50       36.60


          NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE           MARYLAND
                     AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                   MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.010
                                 0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION               1.808   1.879   2.771   2.254   1.951   4.917
                                 1.762   3.459   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED       5.0739  1.4470  0.7542  0.5364  0.5165  0.3130
  FROM LAYER  7                  0.2874  0.3331  0.2286  0.7464  2.5734  1.0746

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                    MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.041   0.013   0.006   0.004   0.004   0.003
  TOP OF LAYER  8                0.002   0.003   0.002   0.006   0.021   0.009

STD. DEVIATION OF DAILY          0.017   0.003   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.011   0.009   0.003

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
```

```
                                       --------      ----------   -------
 PRECIPITATION                          44.01        159756.297   100.00

 RUNOFF                                  2.038         7397.457     4.63

 EVAPOTRANSPIRATION                     28.526       103548.383    64.82

 DRAINAGE COLLECTED FROM LAYER  7       13.8844       50400.195    31.55

 PERC./LEAKAGE THROUGH LAYER  8          0.000002         0.009     0.00

 AVG. HEAD ON TOP OF LAYER  8            0.0095

 CHANGE IN WATER STORAGE                -0.438        -1589.801    -1.00

 SOIL WATER AT START OF YEAR            55.657       202033.422

 SOIL WATER AT END OF YEAR              55.219       200443.625

 SNOW WATER AT START OF YEAR             0.000            0.000     0.00

 SNOW WATER AT END OF YEAR               0.000            0.000     0.00

 ANNUAL WATER BUDGET BALANCE             0.0000           0.052     0.00

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        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                          0.000    0.043    1.705    0.045    0.000    0.233

   STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
```

```
   TOTALS                 1.808    1.879    2.771    2.254    1.951    4.917
                          1.762    3.459    1.126    3.011    2.304    1.282

   STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                 5.0739   1.4470   0.7542   0.5364   0.5165   0.3130
                          0.2874   0.3331   0.2286   0.7464   2.5734   1.0746

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES               0.0409   0.0129   0.0061   0.0045   0.0042   0.0026
                          0.0023   0.0027   0.0019   0.0060   0.0214   0.0087

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES           CU. FEET      PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           2.038   (  0.0000)      7397.46      4.630

 EVAPOTRANSPIRATION              28.526   (  0.0000)    103548.38     64.816

 LATERAL DRAINAGE COLLECTED      13.88435 (  0.00000)    50400.195   31.54818
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8
```

```
 AVERAGE HEAD ON TOP             0.010 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE        -0.438   (  0.0000)      -1589.80     -0.995

*******************************************************************************


******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
       PRECIPITATION                                6.16        22360.799

       RUNOFF                                       1.705        6189.2476

       DRAINAGE COLLECTED FROM LAYER  7             0.27842      1010.65479

       PERCOLATION/LEAKAGE THROUGH LAYER  8         0.000000        0.00003

       AVERAGE HEAD ON TOP OF LAYER  8              0.070

       MAXIMUM HEAD ON TOP OF LAYER  8              0.138

       LOCATION OF MAXIMUM HEAD IN LAYER  7
             (DISTANCE FROM DRAIN)                  1.3 FEET

       SNOW WATER                                   0.77         2798.9209


       MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.4530

       MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.0850


        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.

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                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1            2.6051         0.2171

                    2           21.9203         0.0761

                    3            3.5029         0.2919

                    4            7.5255         0.0784

                    5           14.1772         0.2954

                    6            5.4768         0.2282

                    7            0.0093         0.0623

                    8            0.0000         0.0000

                SNOW WATER       0.000

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ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 4 LIFTS

Floor slope 5%

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF4S5.OUT


TIME:  13: 0     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 4 LIFTS, S = 5%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                      LAYER  2
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
 THICKNESS                  =    288.00   INCHES
 POROSITY                   =      0.1680 VOL/VOL
 FIELD CAPACITY             =      0.0730 VOL/VOL
 WILTING POINT              =      0.0190 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                      LAYER  3
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   6
 THICKNESS                  =     12.00   INCHES
 POROSITY                   =      0.4530 VOL/VOL
 FIELD CAPACITY             =      0.1900 VOL/VOL
 WILTING POINT              =      0.0850 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.2164 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC



                      LAYER  4
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
 THICKNESS                  =     96.00   INCHES
 POROSITY                   =      0.1680 VOL/VOL
 FIELD CAPACITY             =      0.0730 VOL/VOL
 WILTING POINT              =      0.0190 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                      LAYER  5
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   6
 THICKNESS                  =     48.00   INCHES
 POROSITY                   =      0.4530 VOL/VOL
 FIELD CAPACITY             =      0.1900 VOL/VOL
 WILTING POINT              =      0.0850 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                      LAYER  6
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
 THICKNESS                  =     24.00   INCHES
 POROSITY                   =      0.4570 VOL/VOL
 FIELD CAPACITY             =      0.1310 VOL/VOL
 WILTING POINT              =      0.0580 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.2707 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                      LAYER  7
                      --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
 THICKNESS                  =      0.15   INCHES
 POROSITY                   =      0.8500 VOL/VOL
 FIELD CAPACITY             =      0.0100 VOL/VOL
 WILTING POINT              =      0.0050 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.3089 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
 SLOPE                      =      5.00   PERCENT
 DRAINAGE LENGTH            =    250.0    FEET



                      LAYER  8
                      --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
 THICKNESS                  =      0.06   INCHES
 POROSITY                   =      0.0000 VOL/VOL
 FIELD CAPACITY             =      0.0000 VOL/VOL
 WILTING POINT              =      0.0000 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
 FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
 FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
 FML PLACEMENT QUALITY      =  1 - PERFECT



                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     54.385  INCHES
   TOTAL INITIAL WATER                =     54.385  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
          NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE          MARYLAND
                     AND STATION LATITUDE  =  39.18 DEGREES



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                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.010
                                 0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION               1.805   1.879   2.771   2.254   1.951   4.910
                                 1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED       3.9747  1.3228  0.7412  0.5147  0.5126  0.3096
  FROM LAYER  7                  0.2849  0.3412  0.2218  0.7454  2.5673  1.0743

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.026   0.009   0.005   0.003   0.003   0.002
  TOP OF LAYER  8                0.002   0.002   0.001   0.005   0.017   0.007

STD. DEVIATION OF DAILY          0.011   0.002   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.009   0.007   0.002

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                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES         CU. FEET     PERCENT
                                       --------       ----------    -------
  PRECIPITATION                          44.01        159756.297    100.00

  RUNOFF                                  2.038         7397.054      4.63
```

```
 EVAPOTRANSPIRATION                    28.531        103566.992     64.83

 DRAINAGE COLLECTED FROM LAYER  7      12.6105        45776.020     28.65

 PERC./LEAKAGE THROUGH LAYER  8         0.000002          0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8           0.0069

 CHANGE IN WATER STORAGE                0.831          3016.147      1.89

 SOIL WATER AT START OF YEAR           54.431        197584.641

 SOIL WATER AT END OF YEAR             55.262        200600.781

 SNOW WATER AT START OF YEAR            0.000             0.000      0.00

 SNOW WATER AT END OF YEAR              0.000             0.000      0.00

 ANNUAL WATER BUDGET BALANCE            0.0000            0.074      0.00

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       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                   2.00     1.42     3.53     1.61     2.69     4.35
                            2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS          0.00     0.00     0.00     0.00     0.00     0.00
                            0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                   0.000    0.000    0.000    0.000    0.000    0.010
                            0.000    0.043    1.705    0.045    0.000    0.233

   STD. DEVIATIONS          0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                   1.805    1.879    2.771    2.254    1.951    4.910
                            1.762    3.475    1.126    3.011    2.304    1.282

   STD. DEVIATIONS          0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                 3.9747   1.3228   0.7412   0.5147   0.5126   0.3096
                          0.2849   0.3412   0.2218   0.7454   2.5673   1.0743

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES               0.0256   0.0094   0.0048   0.0034   0.0033   0.0021
                          0.0018   0.0022   0.0015   0.0048   0.0171   0.0069

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES              CU. FEET     PERCENT
                               -------------------     -------------  ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           2.038   (  0.0000)       7397.05      4.630

 EVAPOTRANSPIRATION              28.531   (  0.0000)     103566.99     64.828

 LATERAL DRAINAGE COLLECTED      12.61047 (  0.00000)     45776.020   28.65366
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.007 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.831   (  0.0000)       3016.15      1.888

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------   -------------
      PRECIPITATION                             6.16         22360.799

      RUNOFF                                    1.705         6189.2476

      DRAINAGE COLLECTED FROM LAYER  7          0.23067        837.33032

      PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  8           0.046

      MAXIMUM HEAD ON TOP OF LAYER  8           0.090

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)               5.2 FEET

      SNOW WATER                                0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           2.6051         0.2171

                      2          21.9203         0.0761

                      3           3.5029         0.2919

                      4           7.5255         0.0784

                      5          14.1773         0.2954

                      6           5.4767         0.2282

                      7           0.0077         0.0516

                      8           0.0000         0.0000

                  SNOW WATER      0.000

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ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 4 LIFTS

Floor slope 6%

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF4S6.OUT


TIME:  13: 4     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 4 LIFTS, S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    288.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2186 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC



                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0764 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2831 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                   =     24.00   INCHES
  POROSITY                    =      0.4570 VOL/VOL
  FIELD CAPACITY              =      0.1310 VOL/VOL
  WILTING POINT               =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2704 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =      0.15   INCHES
  POROSITY                    =      0.8500 VOL/VOL
  FIELD CAPACITY              =      0.0100 VOL/VOL
  WILTING POINT               =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2611 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
  SLOPE                       =      6.00   PERCENT
  DRAINAGE LENGTH             =    250.0    FEET



                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =      0.06   INCHES
  POROSITY                    =      0.0000 VOL/VOL
  FIELD CAPACITY              =      0.0000 VOL/VOL
  WILTING POINT               =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY       =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     54.411  INCHES
   TOTAL INITIAL WATER                =     54.411  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                      =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX               =   0.00
        START OF GROWING SEASON (JULIAN DATE) =    102
        END OF GROWING SEASON (JULIAN DATE)   =    300
        EVAPORATIVE ZONE DEPTH                =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED             =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                               JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                               ------- ------- ------- ------- ------- -------

PRECIPITATION                   2.00    1.42    3.53    1.61    2.69    4.35
                                2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                          0.000   0.000   0.000   0.000   0.000   0.010
                                0.000   0.046   1.706   0.046   0.000   0.253

EVAPOTRANSPIRATION              1.804   1.891   2.770   2.246   1.962   4.890
                                1.762   3.477   1.127   3.025   2.302   1.281

LATERAL DRAINAGE COLLECTED      3.9817  1.3350  0.7452  0.5143  0.5128  0.3064
  FROM LAYER  7                 0.2802  0.3488  0.2155  0.6969  2.5951  1.0564

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.021   0.008   0.004   0.003   0.003   0.002
  TOP OF LAYER  8               0.002   0.002   0.001   0.004   0.014   0.006

STD. DEVIATION OF DAILY         0.009   0.002   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8       0.000   0.000   0.000   0.007   0.006   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                            INCHES          CU. FEET     PERCENT
                                           --------        ----------    -------
  PRECIPITATION                              44.01         159756.297    100.00

  RUNOFF                                      2.063          7488.505      4.69
```

```
  EVAPOTRANSPIRATION                    28.539       103595.297     64.85

  DRAINAGE COLLECTED FROM LAYER  7      12.5884       45695.930     28.60

  PERC./LEAKAGE THROUGH LAYER  8         0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8           0.0058

  CHANGE IN WATER STORAGE                0.820         2976.557      1.86

  SOIL WATER AT START OF YEAR           54.450       197654.562

  SOIL WATER AT END OF YEAR             55.270       200631.109

  SNOW WATER AT START OF YEAR            0.000            0.000      0.00

  SNOW WATER AT END OF YEAR              0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000          -0.002      0.00

*******************************************************************************




*******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                0.000    0.000    0.000    0.000    0.000    0.010
                          0.000    0.046    1.706    0.046    0.000    0.253

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                1.804    1.891    2.770    2.246    1.962    4.890
                          1.762    3.477    1.127    3.025    2.302    1.281

    STD. DEVIATIONS       0.000    0.000    0.000    0.000    0.000    0.000
                          0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 3.9817   1.3350   0.7452   0.5143   0.5128   0.3064
                           0.2802   0.3488   0.2155   0.6969   2.5951   1.0564

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0214   0.0080   0.0040   0.0029   0.0028   0.0017
                           0.0015   0.0019   0.0012   0.0038   0.0144   0.0057

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                   INCHES           CU. FEET       PERCENT
                             -------------------  -------------   ---------
 PRECIPITATION                 44.01    (   0.000)    159756.3     100.00

 RUNOFF                         2.063   (  0.0000)      7488.51      4.687

 EVAPOTRANSPIRATION            28.539   (  0.0000)    103595.30     64.846

 LATERAL DRAINAGE COLLECTED    12.58841 (  0.00000)    45695.930   28.60352
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH    0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP            0.006 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE        0.820   (  0.0000)      2976.56      1.863

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
     PRECIPITATION                              6.16        22360.799

     RUNOFF                                     1.706        6193.2847

     DRAINAGE COLLECTED FROM LAYER  7           0.23525       853.96918

     PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000        0.00002

     AVERAGE HEAD ON TOP OF LAYER  8            0.039

     MAXIMUM HEAD ON TOP OF LAYER  8            0.077

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)                5.0 FEET

     SNOW WATER                                 0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.


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```

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1           2.6243         0.2187

                   2          22.2813         0.0774

                   3           3.4930         0.2911

                   4           7.2628         0.0757

                   5          14.2196         0.2962

                   6           5.3422         0.2226

                   7           0.0079         0.0528

                   8           0.0000         0.0000

               SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 4 LIFTS

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                    USAE WATERWAYS EXPERIMENT STATION                    **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF4S33.OUT


TIME:  10:39     DATE:   6/26/2020


******************************************************************************

     TITLE:  MID FILL @ 4 LIFTS; S = 33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    288.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2221 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0782 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2814 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2791 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0269 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
SLOPE                       =     33.00   PERCENT
DRAINAGE LENGTH             =     75.0    FEET


                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  1 - PERFECT


        GENERAL DESIGN AND EVAPORATIVE ZONE DATA
        ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER              =     86.00
   FRACTION OF AREA ALLOWING RUNOFF     =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH               =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE    =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.765  INCHES
   INITIAL SNOW WATER                   =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS     =     54.718  INCHES
   TOTAL INITIAL WATER                  =     54.718  INCHES
   TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                         =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                  =   0.00
        START OF GROWING SEASON (JULIAN DATE)    =    102
        END OF GROWING SEASON (JULIAN DATE)      =    300
        EVAPORATIVE ZONE DEPTH                   =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.001   0.000   0.000   0.000   0.000   0.011
                                 0.000   0.055   1.652   0.046   0.002   0.332

EVAPOTRANSPIRATION               1.825   1.860   2.422   2.070   1.747   4.392
                                 1.480   3.464   0.920   3.065   2.340   1.287

LATERAL DRAINAGE COLLECTED       4.2507  1.3503  0.7796  0.5350  0.3401  0.4495
  FROM LAYER  7                  0.5111  0.2744  0.3474  2.0054  2.7316  1.0724

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                 MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.001   0.000   0.000   0.000   0.000   0.000
  TOP OF LAYER  8                0.000   0.000   0.000   0.001   0.001   0.000

STD. DEVIATION OF DAILY          0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.001   0.000   0.000

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
                                         --------       ----------    -------
  PRECIPITATION                            44.01        159756.297    100.00

  RUNOFF                                    2.100         7622.630      4.77
```

```
  EVAPOTRANSPIRATION                      26.873         97548.234     61.06

  DRAINAGE COLLECTED FROM LAYER  7        14.6476        53170.883     33.28

  PERC./LEAKAGE THROUGH LAYER  8           0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0004

  CHANGE IN WATER STORAGE                  0.390          1414.479      0.89

  SOIL WATER AT START OF YEAR             54.722        198640.969

  SOIL WATER AT END OF YEAR               55.112        200055.453

  SNOW WATER AT START OF YEAR              0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000            0.061      0.00

*******************************************************************************




*******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.001    0.000    0.000    0.000    0.000    0.011
                           0.000    0.055    1.652    0.046    0.002    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.825    1.860    2.422    2.070    1.747    4.392
                           1.480    3.464    0.920    3.065    2.340    1.287

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 4.2507   1.3503   0.7796   0.5350   0.3401   0.4495
                           0.5111   0.2744   0.3474   2.0054   2.7316   1.0724

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0014   0.0005   0.0003   0.0002   0.0001   0.0002
                           0.0002   0.0001   0.0001   0.0007   0.0009   0.0003

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                       INCHES            CU. FEET     PERCENT
                                 -------------------   -------------  ---------
 PRECIPITATION                     44.01    (   0.000)     159756.3    100.00

 RUNOFF                             2.100   (  0.0000)      7622.63      4.771

 EVAPOTRANSPIRATION                26.873   (  0.0000)     97548.23     61.061

 LATERAL DRAINAGE COLLECTED        14.64763 (  0.00000)    53170.883    33.28250
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)        0.009     0.00001
   LAYER  8

 AVERAGE HEAD ON TOP                0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE            0.390   (  0.0000)      1414.48      0.885

*******************************************************************************
```

```
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------   -------------
      PRECIPITATION                             6.16        22360.799

      RUNOFF                                    1.652        5996.8691

      DRAINAGE COLLECTED FROM LAYER  7          0.27591      1001.53583

      PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  8           0.003

      MAXIMUM HEAD ON TOP OF LAYER  8           0.005

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)               0.0 FEET

      SNOW WATER                                0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.3770

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           2.6622         0.2218

                      2          22.4278         0.0779

                      3           3.4588         0.2882

                      4           7.3624         0.0767

                      5          13.8701         0.2890

                      6           5.3248         0.2219

                      7           0.0015         0.0102

                      8           0.0000         0.0000

                  SNOW WATER      0.000

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ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 6.5 LIFTS

Floor slope 2%

```
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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF6-5S2.OUT


TIME:  13:13     DATE:   6/24/2020


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     TITLE:  MID FILL @ 6.5 LIFTS, S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    528.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2680 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7418 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    250.0    FEET


                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------
```

```
    NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     72.510  INCHES
   TOTAL INITIAL WATER                 =     72.510  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


              EVAPOTRANSPIRATION AND WEATHER DATA
              -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                         =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                  =   0.00
        START OF GROWING SEASON (JULIAN DATE)    =    102
        END OF GROWING SEASON (JULIAN DATE)      =    300
        EVAPORATIVE ZONE DEPTH                   =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    3.47        3.02        3.93        3.00        3.89        3.43
    3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   32.40       35.50       43.70       53.20       62.80       71.70
```

```
   76.50       74.50       67.40       55.30       45.50       36.60


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND
               AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                             JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                             ------- ------- ------- ------- ------- -------

PRECIPITATION                 2.00    1.42    3.53    1.61    2.69    4.35
                              2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                        0.000   0.000   0.000   0.000   0.000   0.010
                              0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION            1.811   1.893   2.700   2.247   1.953   4.921
                              1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED    4.2913  1.5346  0.7668  0.5467  0.5373  0.2924
  FROM LAYER  7               0.2833  0.3650  0.2178  0.5604  2.8352  1.0863

PERCOLATION/LEAKAGE THROUGH   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                    0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON         0.069   0.027   0.012   0.009   0.009   0.005
  TOP OF LAYER  8             0.005   0.006   0.004   0.009   0.047   0.017

STD. DEVIATION OF DAILY       0.027   0.006   0.003   0.001   0.002   0.001
  HEAD ON TOP OF LAYER  8     0.001   0.000   0.001   0.020   0.023   0.005

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES         CU. FEET     PERCENT
```

```
                                              --------        ----------    -------
  PRECIPITATION                                44.01          159756.297    100.00

  RUNOFF                                        2.022           7340.542      4.59

  EVAPOTRANSPIRATION                           28.415         103145.367     64.56

  DRAINAGE COLLECTED FROM LAYER  7             13.3168         48340.027     30.26

  PERC./LEAKAGE THROUGH LAYER  8                0.000003           0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8                  0.0183

  CHANGE IN WATER STORAGE                       0.256            930.376      0.58

  SOIL WATER AT START OF YEAR                  72.621         263613.844

  SOIL WATER AT END OF YEAR                    72.877         264544.219

  SNOW WATER AT START OF YEAR                   0.000              0.000      0.00

  SNOW WATER AT END OF YEAR                     0.000              0.000      0.00

  ANNUAL WATER BUDGET BALANCE                   0.0000            -0.026      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                            2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                            0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
```

```
    TOTALS                 1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                4.2913   1.5346   0.7668   0.5467   0.5373   0.2924
                          0.2833   0.3650   0.2178   0.5604   2.8352   1.0863

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

-------------------------------------------------------------------------------
                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES              0.0691   0.0274   0.0123   0.0091   0.0086   0.0049
                          0.0046   0.0059   0.0036   0.0090   0.0472   0.0175

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                       INCHES            CU. FEET      PERCENT
                                 -------------------   -------------  ---------
 PRECIPITATION                     44.01    (   0.000)     159756.3     100.00

 RUNOFF                             2.022   (  0.0000)       7340.54      4.595

 EVAPOTRANSPIRATION                28.415   (  0.0000)     103145.37     64.564

 LATERAL DRAINAGE COLLECTED        13.31681 (  0.00000)     48340.027    30.25861
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)         0.009     0.00001
   LAYER  8
```

```
 AVERAGE HEAD ON TOP              0.018 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.256   (  0.0000)        930.38      0.582

*******************************************************************************


******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
      PRECIPITATION                              6.16         22360.799

      RUNOFF                                     1.702         6179.5317

      DRAINAGE COLLECTED FROM LAYER  7           0.24331        883.21838

      PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000         0.00005

      AVERAGE HEAD ON TOP OF LAYER  8            0.121

      MAXIMUM HEAD ON TOP OF LAYER  8            0.238

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)                4.4 FEET

      SNOW WATER                                 0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1           2.5575         0.2131

                      2          40.2548         0.0762

                      3           3.4776         0.2898

                      4           7.2711         0.0757

                      5          13.8495         0.2885

                      6           5.3530         0.2230

                      7           0.0024         0.0157

                      8           0.0000         0.0000

                  SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 6.5 LIFTS

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF6-5S3.OUT


TIME:  13:16     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 6.5 LIFTS, S = 3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                 LAYER  1
                                 --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    528.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2679 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.4879 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
SLOPE                      =      3.00   PERCENT
DRAINAGE LENGTH            =    250.0    FEET


                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT



        GENERAL DESIGN AND EVAPORATIVE ZONE DATA
        ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     72.469  INCHES
   TOTAL INITIAL WATER                 =     72.469  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                      =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX               =   0.00
        START OF GROWING SEASON (JULIAN DATE) =    102
        END OF GROWING SEASON (JULIAN DATE)   =    300
        EVAPORATIVE ZONE DEPTH                =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED             =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                   2.00    1.42    3.53    1.61    2.69    4.35
                                2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                          0.000   0.000   0.000   0.000   0.000   0.010
                                0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION              1.811   1.893   2.700   2.247   1.953   4.921
                                1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED      4.2622  1.5286  0.7638  0.5475  0.5358  0.2921
  FROM LAYER  7                 0.2833  0.3656  0.2168  0.5891  2.8117  1.0809

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                 MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.046   0.018   0.008   0.006   0.006   0.003
  TOP OF LAYER  8               0.003   0.004   0.002   0.006   0.031   0.012

STD. DEVIATION OF DAILY         0.018   0.004   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8       0.000   0.000   0.001   0.014   0.015   0.003

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET     PERCENT
                                       --------      ----------    -------
  PRECIPITATION                          44.01       159756.297    100.00

  RUNOFF                                  2.022        7340.542      4.59
```

```
 EVAPOTRANSPIRATION                     28.415       103145.367     64.56

 DRAINAGE COLLECTED FROM LAYER  7       13.2772       48196.180     30.17

 PERC./LEAKAGE THROUGH LAYER  8          0.000002         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8            0.0121

 CHANGE IN WATER STORAGE                 0.296         1074.277      0.67

 SOIL WATER AT START OF YEAR            72.542       263328.656

 SOIL WATER AT END OF YEAR              72.838       264402.937

 SNOW WATER AT START OF YEAR             0.000            0.000      0.00

 SNOW WATER AT END OF YEAR               0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE             0.0000          -0.081      0.00

******************************************************************************




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       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 4.2622   1.5286   0.7638   0.5475   0.5358   0.2921
                           0.2833   0.3656   0.2168   0.5891   2.8117   1.0809

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0458   0.0182   0.0082   0.0061   0.0058   0.0032
                           0.0030   0.0039   0.0024   0.0063   0.0312   0.0116

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************



******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                     INCHES            CU. FEET      PERCENT
                               -------------------   -------------  ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           2.022   (  0.0000)      7340.54      4.595

 EVAPOTRANSPIRATION              28.415   (  0.0000)    103145.37     64.564

 LATERAL DRAINAGE COLLECTED      13.27718 (  0.00000)    48196.180   30.16856
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.012 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.296   (  0.0000)      1074.28      0.672

******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                            6.16         22360.799

      RUNOFF                                   1.702         6179.5317

      DRAINAGE COLLECTED FROM LAYER  7         0.25451        923.86218

      PERCOLATION/LEAKAGE THROUGH LAYER  8     0.000000         0.00003

      AVERAGE HEAD ON TOP OF LAYER  8          0.085

      MAXIMUM HEAD ON TOP OF LAYER  8          0.168

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)              2.5 FEET

      SNOW WATER                               0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.5575         0.2131

                      2           40.2548         0.0762

                      3            3.4776         0.2898

                      4            7.2711         0.0757

                      5           13.8495         0.2885

                      6            5.3530         0.2230

                      7            0.0015         0.0101

                      8            0.0000         0.0000

                  SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

MID-HEIGHT – 6.5 LIFTS

Floor slope 4%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF6-5S4.OUT


TIME:  13:20     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 6.5 LIFTS, S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =    528.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     12.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2148 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =     96.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     48.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
     THICKNESS                  =     24.00   INCHES
     POROSITY                   =      0.4570 VOL/VOL
     FIELD CAPACITY             =      0.1310 VOL/VOL
     WILTING POINT              =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2707 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                  =      0.15   INCHES
     POROSITY                   =      0.8500 VOL/VOL
     FIELD CAPACITY             =      0.0100 VOL/VOL
     WILTING POINT              =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.3847 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
     SLOPE                      =      4.00   PERCENT
     DRAINAGE LENGTH            =    250.0    FEET


                        LAYER  8
                        --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
     THICKNESS                  =      0.06   INCHES
     POROSITY                   =      0.0000 VOL/VOL
     FIELD CAPACITY             =      0.0000 VOL/VOL
     WILTING POINT              =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
     FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
     FML PLACEMENT QUALITY      =  1 - PERFECT


             GENERAL DESIGN AND EVAPORATIVE ZONE DATA
             ----------------------------------------
```

```
    NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     72.497  INCHES
   TOTAL INITIAL WATER                =     72.497  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR



              EVAPOTRANSPIRATION AND WEATHER DATA
              -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                     =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX              =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    102
        END OF GROWING SEASON (JULIAN DATE)    =    300
        EVAPORATIVE ZONE DEPTH               =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED            =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
```

```
      76.50       74.50       67.40       55.30       45.50       36.60


     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BALTIMORE          MARYLAND
                AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.010
                                  0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION                1.805   1.879   2.771   2.254   1.951   4.910
                                  1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED        4.2675  1.5386  0.7697  0.5554  0.5193  0.3127
  FROM LAYER  7                   0.2872  0.3423  0.2226  0.2553  2.9542  1.1343

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                 MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.034   0.014   0.006   0.005   0.004   0.003
  TOP OF LAYER  8                 0.002   0.003   0.002   0.002   0.025   0.009

STD. DEVIATION OF DAILY           0.014   0.003   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.001   0.012   0.003

*******************************************************************************


*******************************************************************************

                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                           INCHES         CU. FEET     PERCENT
```

```
                                        --------        ----------    -------
  PRECIPITATION                          44.01         159756.297    100.00

  RUNOFF                                  2.038          7397.054      4.63

  EVAPOTRANSPIRATION                     28.531        103566.992     64.83

  DRAINAGE COLLECTED FROM LAYER  7       13.1591        47767.617     29.90

  PERC./LEAKAGE THROUGH LAYER  8          0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8            0.0090

  CHANGE IN WATER STORAGE                 0.282          1024.593      0.64

  SOIL WATER AT START OF YEAR            72.555        263373.062

  SOIL WATER AT END OF YEAR              72.837        264397.656

  SNOW WATER AT START OF YEAR             0.000             0.000      0.00

  SNOW WATER AT END OF YEAR               0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE             0.0000            0.029      0.00

******************************************************************************




******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.043    1.705    0.045    0.000    0.233

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
```

```
    TOTALS                 1.805    1.879    2.771    2.254    1.951    4.910
                           1.762    3.475    1.126    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 4.2675   1.5386   0.7697   0.5554   0.5193   0.3127
                           0.2872   0.3423   0.2226   0.2553   2.9542   1.1343

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0344   0.0137   0.0062   0.0046   0.0042   0.0026
                           0.0023   0.0028   0.0019   0.0021   0.0246   0.0091

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************



******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                       INCHES           CU. FEET      PERCENT
                                 -------------------  -------------  ---------
 PRECIPITATION                     44.01    (   0.000)     159756.3    100.00

 RUNOFF                             2.038   (  0.0000)       7397.05     4.630

 EVAPOTRANSPIRATION                28.531   (  0.0000)     103566.99    64.828

 LATERAL DRAINAGE COLLECTED        13.15912 (  0.00000)     47767.617   29.90030
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)         0.009    0.00001
   LAYER  8
```

```
 AVERAGE HEAD ON TOP             0.009 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         0.282   (  0.0000)       1024.59      0.641

*******************************************************************************



*******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
      PRECIPITATION                              6.16          22360.799

      RUNOFF                                     1.705          6189.2476

      DRAINAGE COLLECTED FROM LAYER  7           0.23096         838.37311

      PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000          0.00003

      AVERAGE HEAD ON TOP OF LAYER  8            0.058

      MAXIMUM HEAD ON TOP OF LAYER  8            0.114

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)                1.7 FEET

      SNOW WATER                                 0.77           2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
*******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.6051         0.2171

                      2           40.0935         0.0759

                      3            3.4778         0.2898

                      4            7.4697         0.0778

                      5           13.8454         0.2884

                      6            5.2832         0.2201

                      7            0.0043         0.0289

                      8            0.0000         0.0000

                  SNOW WATER       0.000

*******************************************************************************
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```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 6.5 LIFTS

Floor slope 5%

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF6-5S5.OUT


TIME:  13:23     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 6.5 LIFTS, S = 5%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    528.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2164 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0757 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2842 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                  =     24.00   INCHES
  POROSITY                   =      0.4570 VOL/VOL
  FIELD CAPACITY             =      0.1310 VOL/VOL
  WILTING POINT              =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.2707 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                  =      0.15   INCHES
  POROSITY                   =      0.8500 VOL/VOL
  FIELD CAPACITY             =      0.0100 VOL/VOL
  WILTING POINT              =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.3809 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
  SLOPE                      =      5.00   PERCENT
  DRAINAGE LENGTH            =    250.0    FEET


                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                  =      0.06   INCHES
  POROSITY                   =      0.0000 VOL/VOL
  FIELD CAPACITY             =      0.0000 VOL/VOL
  WILTING POINT              =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY      =  1 - PERFECT


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     72.516  INCHES
   TOTAL INITIAL WATER                 =     72.516  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.010
                                 0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION               1.805   1.879   2.771   2.254   1.951   4.910
                                 1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED       4.2878  1.5384  0.7691  0.5555  0.5188  0.3126
  FROM LAYER  7                  0.2872  0.3424  0.2225  0.2549  2.9562  1.1327

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.028   0.011   0.005   0.004   0.003   0.002
  TOP OF LAYER  8                0.002   0.002   0.001   0.002   0.020   0.007

STD. DEVIATION OF DAILY          0.011   0.003   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.001   0.009   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES         CU. FEET     PERCENT
                                        --------       ----------    -------
  PRECIPITATION                          44.01         159756.297    100.00

  RUNOFF                                  2.038          7397.054      4.63
```

```
  EVAPOTRANSPIRATION                      28.531        103566.992     64.83

  DRAINAGE COLLECTED FROM LAYER  7        13.1782        47836.762     29.94

  PERC./LEAKAGE THROUGH LAYER  8           0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0072

  CHANGE IN WATER STORAGE                  0.263           955.440      0.60

  SOIL WATER AT START OF YEAR             72.573        263438.625

  SOIL WATER AT END OF YEAR               72.836        264394.062

  SNOW WATER AT START OF YEAR              0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000            0.040      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.043    1.705    0.045    0.000    0.233

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.879    2.771    2.254    1.951    4.910
                           1.762    3.475    1.126    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 4.2878   1.5384   0.7691   0.5555   0.5188   0.3126
                           0.2872   0.3424   0.2225   0.2549   2.9562   1.1327

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0277   0.0110   0.0050   0.0037   0.0033   0.0021
                           0.0019   0.0022   0.0015   0.0016   0.0197   0.0073

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               --------------------- -------------  ----------
 PRECIPITATION                  44.01    (   0.000)    159756.3     100.00

 RUNOFF                          2.038   (  0.0000)      7397.05      4.630

 EVAPOTRANSPIRATION             28.531   (  0.0000)    103566.99     64.828

 LATERAL DRAINAGE COLLECTED     13.17817 (  0.00000)    47836.762   29.94358
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.009     0.00001
   LAYER  8

 AVERAGE HEAD ON TOP             0.007 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         0.263   (  0.0000)       955.44      0.598
*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                            6.16        22360.799

      RUNOFF                                   1.705        6189.2476

      DRAINAGE COLLECTED FROM LAYER  7         0.23816       864.52887

      PERCOLATION/LEAKAGE THROUGH LAYER  8     0.000000        0.00003

      AVERAGE HEAD ON TOP OF LAYER  8          0.048

      MAXIMUM HEAD ON TOP OF LAYER  8          0.095

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)              0.0 FEET

      SNOW WATER                               0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                 FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1            2.6051         0.2171

                    2           40.0935         0.0759

                    3            3.4778         0.2898

                    4            7.4697         0.0778

                    5           13.8454         0.2884

                    6            5.2832         0.2201

                    7            0.0039         0.0261

                    8            0.0000         0.0000

                  SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 6.5 LIFTS

Floor slope 6%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF6-5S6.OUT


TIME:  13:26     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 6.5 LIFTS, S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                      LAYER  2
                      --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
    THICKNESS                  =    528.00   INCHES
    POROSITY                   =      0.1680 VOL/VOL
    FIELD CAPACITY             =      0.0730 VOL/VOL
    WILTING POINT              =      0.0190 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                      LAYER  3
                      --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
    THICKNESS                  =     12.00   INCHES
    POROSITY                   =      0.4530 VOL/VOL
    FIELD CAPACITY             =      0.1900 VOL/VOL
    WILTING POINT              =      0.0850 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2186 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                      LAYER  4
                      --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
    THICKNESS                  =     96.00   INCHES
    POROSITY                   =      0.1680 VOL/VOL
    FIELD CAPACITY             =      0.0730 VOL/VOL
    WILTING POINT              =      0.0190 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0764 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                      LAYER  5
                      --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
    THICKNESS                  =     48.00   INCHES
    POROSITY                   =      0.4530 VOL/VOL
    FIELD CAPACITY             =      0.1900 VOL/VOL
    WILTING POINT              =      0.0850 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2831 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                      LAYER  6
                      --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
    THICKNESS                  =     24.00   INCHES
    POROSITY                   =      0.4570 VOL/VOL
    FIELD CAPACITY             =      0.1310 VOL/VOL
    WILTING POINT              =      0.0580 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2704 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                      LAYER  7
                      --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
    THICKNESS                  =      0.15   INCHES
    POROSITY                   =      0.8500 VOL/VOL
    FIELD CAPACITY             =      0.0100 VOL/VOL
    WILTING POINT              =      0.0050 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2611 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
    SLOPE                      =      6.00   PERCENT
    DRAINAGE LENGTH            =    250.0    FEET


                      LAYER  8
                      --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
    THICKNESS                  =      0.06   INCHES
    POROSITY                   =      0.0000 VOL/VOL
    FIELD CAPACITY             =      0.0000 VOL/VOL
    WILTING POINT              =      0.0000 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
    FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
    FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
    FML PLACEMENT QUALITY      =  1 - PERFECT


            GENERAL DESIGN AND EVAPORATIVE ZONE DATA
            ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
     SCS RUNOFF CURVE NUMBER             =     86.00
     FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
     LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
     INITIAL SNOW WATER                  =      0.000  INCHES
     INITIAL WATER IN LAYER MATERIALS    =     72.531  INCHES
     TOTAL INITIAL WATER                 =     72.531  INCHES
     TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

      NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
               BALTIMORE             MARYLAND

          STATION LATITUDE                       =  39.18 DEGREES
          MAXIMUM LEAF AREA INDEX                =   0.00
          START OF GROWING SEASON (JULIAN DATE)  =    102
          END OF GROWING SEASON (JULIAN DATE)    =    300
          EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
          AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    3.47        3.02        3.93        3.00        3.89        3.43
    3.85        3.74        3.98        3.16        3.12        3.35


      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   32.40       35.50       43.70       53.20       62.80       71.70
   76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.010
                                  0.000   0.046   1.706   0.046   0.000   0.253

EVAPOTRANSPIRATION                1.804   1.891   2.770   2.246   1.962   4.890
                                  1.762   3.477   1.127   3.025   2.302   1.281

LATERAL DRAINAGE COLLECTED        4.2894  1.5469  0.7723  0.5544  0.5189  0.3094
  FROM LAYER  7                   0.2826  0.3500  0.2159  0.2473  2.9442  1.1291

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.023   0.009   0.004   0.003   0.003   0.002
  TOP OF LAYER  8                 0.002   0.002   0.001   0.001   0.016   0.006

STD. DEVIATION OF DAILY           0.009   0.002   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.001   0.008   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           44.01         159756.297    100.00

  RUNOFF                                   2.063          7488.505      4.69
```

```
 EVAPOTRANSPIRATION                  28.539       103595.297     64.85

 DRAINAGE COLLECTED FROM LAYER  7    13.1604       47772.082     29.90

 PERC./LEAKAGE THROUGH LAYER  8       0.000002         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8         0.0060

 CHANGE IN WATER STORAGE              0.248          900.438      0.56

 SOIL WATER AT START OF YEAR         72.570       263430.094

 SOIL WATER AT END OF YEAR           72.818       264330.531

 SNOW WATER AT START OF YEAR          0.000            0.000      0.00

 SNOW WATER AT END OF YEAR            0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE          0.0000          -0.037      0.00

***********************************************************************************



***********************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-----------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.046    1.706    0.046    0.000    0.253

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.804    1.891    2.770    2.246    1.962    4.890
                           1.762    3.477    1.127    3.025    2.302    1.281

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                  4.2894   1.5469   0.7723   0.5544   0.5189   0.3094
                           0.2826   0.3500   0.2159   0.2473   2.9442   1.1291

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-----------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES                0.0231   0.0092   0.0042   0.0031   0.0028   0.0017
                           0.0015   0.0019   0.0012   0.0013   0.0164   0.0061

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

***********************************************************************************



***********************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-----------------------------------------------------------------------------------
                                      INCHES           CU. FEET      PERCENT
                               -------------------   -------------  ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3    100.00

 RUNOFF                           2.063   (  0.0000)      7488.51     4.687

 EVAPOTRANSPIRATION              28.539   (  0.0000)    103595.30    64.846

 LATERAL DRAINAGE COLLECTED      13.16035 (  0.00000)    47772.082   29.90310
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.006 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.248   (  0.0000)       900.44     0.564
***********************************************************************************
```

```
******************************************************************************

            PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                            (INCHES)      (CU. FT.)
                                           ----------   -------------
     PRECIPITATION                           6.16        22360.799

     RUNOFF                                  1.706        6193.2847

     DRAINAGE COLLECTED FROM LAYER  7        0.23173       841.17187

     PERCOLATION/LEAKAGE THROUGH LAYER  8    0.000000        0.00002

     AVERAGE HEAD ON TOP OF LAYER  8         0.039

     MAXIMUM HEAD ON TOP OF LAYER  8         0.079

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)             0.0 FEET

     SNOW WATER                              0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

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******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1            2.6243         0.2187

                 2           40.5144         0.0767

                 3            3.4260         0.2855

                 4            7.2066         0.0751

                 5           13.6685         0.2848

                 6            5.3378         0.2224

                 7            0.0015         0.0100

                 8            0.0000         0.0000

             SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

MID-HEIGHT – 6.5 LIFTS

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF6-5S33.OUT


TIME:  11: 4     DATE:   6/26/2020


******************************************************************************

     TITLE:  MID FILL @ 6.5 LIFTS; S = 33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                      LAYER  2
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    528.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                      LAYER  3
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2221 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                      LAYER  4
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0782 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                      LAYER  5
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2814 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                      LAYER  6
                      --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2791 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                      LAYER  7
                      --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0269 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
SLOPE                       =     33.00   PERCENT
DRAINAGE LENGTH             =     75.0    FEET


                      LAYER  8
                      --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  1 - PERFECT


        GENERAL DESIGN AND EVAPORATIVE ZONE DATA
        ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =    86.00
   FRACTION OF AREA ALLOWING RUNOFF    =    50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =     9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =     1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =     4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =     0.765  INCHES
   INITIAL SNOW WATER                  =     0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =    72.838  INCHES
   TOTAL INITIAL WATER                 =    72.838  INCHES
   TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =   102
        END OF GROWING SEASON (JULIAN DATE)     =   300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
  3.47         3.02         3.93         3.00         3.89         3.43
  3.85         3.74         3.98         3.16         3.12         3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
 32.40        35.50        43.70        53.20        62.80        71.70
 76.50        74.50        67.40        55.30        45.50        36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.001   0.000   0.000   0.000   0.000   0.011
                                  0.000   0.055   1.652   0.046   0.002   0.332

EVAPOTRANSPIRATION                1.825   1.860   2.422   2.070   1.747   4.392
                                  1.480   3.464   0.920   3.065   2.340   1.287

LATERAL DRAINAGE COLLECTED        4.5609  1.5614  0.8036  0.5683  0.3514  0.4580
  FROM LAYER  7                   0.5124  0.2748  0.3498  1.2149  3.4135  1.1621

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.001   0.001   0.000   0.000   0.000   0.000
  TOP OF LAYER  8                 0.000   0.000   0.000   0.000   0.001   0.000

STD. DEVIATION OF DAILY           0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.000   0.001   0.000

*******************************************************************************


*******************************************************************************

                        ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                           INCHES          CU. FEET     PERCENT
                                          --------        ----------    -------
  PRECIPITATION                             44.01         159756.297    100.00

  RUNOFF                                     2.100          7622.630      4.77
```

```
  EVAPOTRANSPIRATION                      26.873        97548.234     61.06

  DRAINAGE COLLECTED FROM LAYER  7        15.2312       55289.234     34.61

  PERC./LEAKAGE THROUGH LAYER  8           0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0004

  CHANGE IN WATER STORAGE                 -0.194         -703.861     -0.44

  SOIL WATER AT START OF YEAR             72.842       264416.531

  SOIL WATER AT END OF YEAR               72.648       263712.656

  SNOW WATER AT START OF YEAR              0.000            0.000      0.00

  SNOW WATER AT END OF YEAR                0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000           0.048      0.00

******************************************************************************




******************************************************************************

       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.001    0.000    0.000    0.000    0.000    0.011
                           0.000    0.055    1.652    0.046    0.002    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.825    1.860    2.422    2.070    1.747    4.392
                           1.480    3.464    0.920    3.065    2.340    1.287

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 4.5609   1.5614   0.8036   0.5683   0.3514   0.4580
                           0.5124   0.2748   0.3498   1.2149   3.4135   1.1621

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0015   0.0006   0.0003   0.0002   0.0001   0.0002
                           0.0002   0.0001   0.0001   0.0004   0.0011   0.0004

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                      INCHES            CU. FEET     PERCENT
                               -------------------   -------------  ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           2.100   (  0.0000)      7622.63     4.771

 EVAPOTRANSPIRATION              26.873   (  0.0000)     97548.23    61.061

 LATERAL DRAINAGE COLLECTED      15.23119 (  0.00000)    55289.234   34.60849
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         -0.194   (  0.0000)      -703.86    -0.441
******************************************************************************
```

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******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              6.16         22360.799

      RUNOFF                                     1.652         5996.8691

      DRAINAGE COLLECTED FROM LAYER  7           0.27590       1001.53326

      PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  8            0.003

      MAXIMUM HEAD ON TOP OF LAYER  8            0.005

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3770

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.6622         0.2218

                      2           40.6901         0.0771

                      3            3.3795         0.2816

                      4            7.3393         0.0765

                      5           13.2675         0.2764

                      6            5.3036         0.2210

                      7            0.0019         0.0125

                      8            0.0000         0.0000

                  SNOW WATER       0.000

******************************************************************************
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```

HELP MODEL PRINTOUTS

MID-HEIGHT – 8.5 LIFTS

Floor slope 2%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************



PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF8-5S2.OUT


TIME:  13:37     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 8.5 LIFTS, S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                     =     12.00   INCHES
           POROSITY                      =      0.4530 VOL/VOL
           FIELD CAPACITY                =      0.1900 VOL/VOL
           WILTING POINT                 =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.720000011000E-03 CM/SEC
```

```
                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =   720.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =    12.00   INCHES
POROSITY                   =     0.4530 VOL/VOL
FIELD CAPACITY             =     0.1900 VOL/VOL
WILTING POINT              =     0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.720000011000E-03 CM/SEC


                    LAYER  4
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    96.00   INCHES
POROSITY                   =     0.1680 VOL/VOL
FIELD CAPACITY             =     0.0730 VOL/VOL
WILTING POINT              =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


                    LAYER  5
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =    48.00   INCHES
POROSITY                   =     0.4530 VOL/VOL
FIELD CAPACITY             =     0.1900 VOL/VOL
WILTING POINT              =     0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.720000011000E-03 CM/SEC
```

```
                    LAYER  6
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =    24.00   INCHES
POROSITY                   =     0.4570 VOL/VOL
FIELD CAPACITY             =     0.1310 VOL/VOL
WILTING POINT              =     0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2680 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


                    LAYER  7
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     0.15   INCHES
POROSITY                   =     0.8500 VOL/VOL
FIELD CAPACITY             =     0.0100 VOL/VOL
WILTING POINT              =     0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.7418 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  4.42000008000     CM/SEC
SLOPE                      =     2.00   PERCENT
DRAINAGE LENGTH            =   250.0    FEET


                    LAYER  8
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =     0.06   INCHES
POROSITY                   =     0.0000 VOL/VOL
FIELD CAPACITY             =     0.0000 VOL/VOL
WILTING POINT              =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =     0.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =     0.00   HOLES/ACRE
FML PLACEMENT QUALITY      = 1 - PERFECT


        GENERAL DESIGN AND EVAPORATIVE ZONE DATA
        ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     87.006  INCHES
   TOTAL INITIAL WATER                =     87.006  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                       =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    102
        END OF GROWING SEASON (JULIAN DATE)    =    300
        EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                  2.00    1.42    3.53    1.61    2.69    4.35
                               2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                         0.000   0.000   0.000   0.000   0.000   0.010
                               0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION             1.811   1.893   2.700   2.247   1.953   4.921
                               1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED     4.5604  1.6857  0.7875  0.5765  0.5412  0.2944
  FROM LAYER  7                0.2852  0.3654  0.2182  0.2781  3.0659  1.1275

PERCOLATION/LEAKAGE THROUGH    0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON          0.073   0.030   0.013   0.010   0.009   0.005
  TOP OF LAYER  8              0.005   0.006   0.004   0.004   0.051   0.018

STD. DEVIATION OF DAILY        0.026   0.008   0.003   0.001   0.002   0.001
  HEAD ON TOP OF LAYER  8      0.001   0.000   0.001   0.003   0.025   0.004

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES        CU. FEET     PERCENT
                                         --------      ----------    -------
  PRECIPITATION                            44.01       159756.297    100.00

  RUNOFF                                    2.022        7340.542      4.59
```

```
 EVAPOTRANSPIRATION                  28.415        103145.367     64.56

 DRAINAGE COLLECTED FROM LAYER  7     13.7861        50043.457     31.32

 PERC./LEAKAGE THROUGH LAYER  8        0.000003          0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8          0.0189

 CHANGE IN WATER STORAGE             -0.213          -773.098     -0.48

 SOIL WATER AT START OF YEAR         87.117        316234.312

 SOIL WATER AT END OF YEAR           86.904        315461.219

 SNOW WATER AT START OF YEAR          0.000             0.000      0.00

 SNOW WATER AT END OF YEAR            0.000             0.000      0.00

 ANNUAL WATER BUDGET BALANCE          0.0000            0.016      0.00

*******************************************************************************




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       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                  4.5604   1.6857   0.7875   0.5765   0.5412   0.2944
                           0.2852   0.3654   0.2182   0.2781   3.0659   1.1275

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES                0.0734   0.0300   0.0127   0.0096   0.0087   0.0049
                           0.0046   0.0059   0.0036   0.0045   0.0510   0.0182

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET      PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           2.022   (  0.0000)      7340.54      4.595

 EVAPOTRANSPIRATION              28.415   (  0.0000)    103145.37     64.564

 LATERAL DRAINAGE COLLECTED      13.78608 (  0.00000)    50043.457   31.32487
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.019 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         -0.213   (  0.0000)      -773.10     -0.484
*******************************************************************************
```

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******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
     PRECIPITATION                             6.16         22360.799

     RUNOFF                                    1.702         6179.5317

     DRAINAGE COLLECTED FROM LAYER  7          0.24371        884.65076

     PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000         0.00005

     AVERAGE HEAD ON TOP OF LAYER  8           0.122

     MAXIMUM HEAD ON TOP OF LAYER  8           0.239

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)               4.4 FEET

     SNOW WATER                                0.77          2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.5575         0.2131

                      2           54.5663         0.0758

                      3            3.4513         0.2876

                      4            7.2273         0.0753

                      5           13.6372         0.2841

                      6            5.3496         0.2229

                      7            0.0035         0.0230

                      8            0.0000         0.0000

                  SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 8.5 LIFTS

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF8-5S3.OUT


TIME:  13:40     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 8.5 LIFTS, S = 3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  2
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    720.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                       LAYER  3
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2148 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC



                       LAYER  4
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0752 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                       LAYER  5
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2857 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2680 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                       LAYER  7
                       --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4879 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
SLOPE                      =      3.00   PERCENT
DRAINAGE LENGTH            =    250.0    FEET



                       LAYER  8
                       --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     86.968  INCHES
   TOTAL INITIAL WATER                 =     86.968  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
      NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE          MARYLAND
                 AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                  2.00    1.42    3.53    1.61    2.69    4.35
                               2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                         0.000   0.000   0.000   0.000   0.000   0.010
                               0.000   0.040   1.702   0.046   0.000   0.224

EVAPOTRANSPIRATION             1.811   1.893   2.700   2.247   1.953   4.921
                               1.729   3.442   1.119   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED     4.5358  1.6777  0.7845  0.5772  0.5396  0.2942
  FROM LAYER  7                0.2852  0.3661  0.2173  0.2869  3.0626  1.1229

PERCOLATION/LEAKAGE THROUGH    0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

AVERAGE DAILY HEAD ON          0.049   0.020   0.008   0.006   0.006   0.003
  TOP OF LAYER  8              0.003   0.004   0.002   0.003   0.034   0.012

STD. DEVIATION OF DAILY        0.018   0.005   0.002   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8      0.000   0.000   0.001   0.002   0.017   0.003

*******************************************************************************


*******************************************************************************

                        ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET     PERCENT
                                       --------      ----------    -------
  PRECIPITATION                          44.01       159756.297    100.00

  RUNOFF                                  2.022        7340.542      4.59
```

```
  EVAPOTRANSPIRATION                      28.415        103145.367     64.56

  DRAINAGE COLLECTED FROM LAYER  7        13.7499        49912.102     31.24

  PERC./LEAKAGE THROUGH LAYER  8           0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0126

  CHANGE IN WATER STORAGE                 -0.177          -641.714     -0.40

  SOIL WATER AT START OF YEAR             87.041        315957.875

  SOIL WATER AT END OF YEAR               86.864        315316.156

  SNOW WATER AT START OF YEAR              0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.012      0.00

*******************************************************************************




*******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.040    1.702    0.046    0.000    0.224

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.811    1.893    2.700    2.247    1.953    4.921
                           1.729    3.442    1.119    3.011    2.305    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 4.5358   1.6777   0.7845   0.5772   0.5396   0.2942
                           0.2852   0.3661   0.2173   0.2869   3.0626   1.1229

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0487   0.0199   0.0084   0.0064   0.0058   0.0033
                           0.0031   0.0039   0.0024   0.0031   0.0340   0.0121

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                    INCHES            CU. FEET      PERCENT
                              -------------------   -------------   ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          2.022   (  0.0000)       7340.54      4.595

 EVAPOTRANSPIRATION             28.415   (  0.0000)     103145.37     64.564

 LATERAL DRAINAGE COLLECTED     13.74989 (  0.00000)     49912.102   31.24265
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP             0.013 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE        -0.177   (  0.0000)       -641.71     -0.402

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                           6.16        22360.799

      RUNOFF                                  1.702        6179.5317

      DRAINAGE COLLECTED FROM LAYER  7        0.25364       920.71338

      PERCOLATION/LEAKAGE THROUGH LAYER  8    0.000000        0.00003

      AVERAGE HEAD ON TOP OF LAYER  8         0.084

      MAXIMUM HEAD ON TOP OF LAYER  8         0.167

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)             2.4 FEET

      SNOW WATER                              0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

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******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.5575         0.2131

                  2           54.5663         0.0758

                  3            3.4513         0.2876

                  4            7.2273         0.0753

                  5           13.6372         0.2841

                  6            5.3496         0.2229

                  7            0.0016         0.0104

                  8            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices

a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 8.5 LIFTS

Floor slope 4%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\MF8-5S4.OUT


TIME:  13:43     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 8.5 LIFTS, S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                 =    720.00   INCHES
POROSITY                  =      0.1680 VOL/VOL
FIELD CAPACITY            =      0.0730 VOL/VOL
WILTING POINT             =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                 =     12.00   INCHES
POROSITY                  =      0.4530 VOL/VOL
FIELD CAPACITY            =      0.1900 VOL/VOL
WILTING POINT             =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2164 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                 =     96.00   INCHES
POROSITY                  =      0.1680 VOL/VOL
FIELD CAPACITY            =      0.0730 VOL/VOL
WILTING POINT             =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0757 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                 =     48.00   INCHES
POROSITY                  =      0.4530 VOL/VOL
FIELD CAPACITY            =      0.1900 VOL/VOL
WILTING POINT             =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2842 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                 =     24.00   INCHES
  POROSITY                  =      0.4570 VOL/VOL
  FIELD CAPACITY            =      0.1310 VOL/VOL
  WILTING POINT             =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2707 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                 =      0.15   INCHES
  POROSITY                  =      0.8500 VOL/VOL
  FIELD CAPACITY            =      0.0100 VOL/VOL
  WILTING POINT             =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.3847 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
  SLOPE                     =      4.00   PERCENT
  DRAINAGE LENGTH           =    250.0    FEET


                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                 =      0.06   INCHES
  POROSITY                  =      0.0000 VOL/VOL
  FIELD CAPACITY            =      0.0000 VOL/VOL
  WILTING POINT             =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY       =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS  =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY     =  1 - PERFECT


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     87.012  INCHES
   TOTAL INITIAL WATER                =     87.012  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE            MARYLAND

        STATION LATITUDE                      =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX               =   0.00
        START OF GROWING SEASON (JULIAN DATE) =    102
        END OF GROWING SEASON (JULIAN DATE)   =    300
        EVAPORATIVE ZONE DEPTH                =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED             =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE          MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
          NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                   COEFFICIENTS FOR    BALTIMORE          MARYLAND
                     AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.010
                                 0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION               1.805   1.879   2.771   2.254   1.951   4.910
                                 1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED      4.5527  1.6926  0.7910  0.5848  0.5234  0.3149
  FROM LAYER  7                 0.2889  0.3430  0.2228  0.2814  2.8655  1.1806

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.037   0.015   0.006   0.005   0.004   0.003
  TOP OF LAYER  8                0.002   0.003   0.002   0.002   0.024   0.010

STD. DEVIATION OF DAILY          0.013   0.004   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.001   0.013   0.003

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                           INCHES        CU. FEET    PERCENT
                                          --------      ----------   -------
  PRECIPITATION                             44.01       159756.297   100.00

  RUNOFF                                     2.038        7397.054     4.63
```

```
 EVAPOTRANSPIRATION                    28.531       103566.992     64.83

 DRAINAGE COLLECTED FROM LAYER  7      13.6416       49519.062     31.00

 PERC./LEAKAGE THROUGH LAYER  8         0.000002         0.009      0.00

 AVG. HEAD ON TOP OF LAYER  8           0.0094

 CHANGE IN WATER STORAGE               -0.200          -726.903    -0.46

 SOIL WATER AT START OF YEAR           87.070       316063.281

 SOIL WATER AT END OF YEAR             86.870       315336.375

 SNOW WATER AT START OF YEAR            0.000            0.000      0.00

 SNOW WATER AT END OF YEAR              0.000            0.000      0.00

 ANNUAL WATER BUDGET BALANCE            0.0000           0.081      0.00

******************************************************************************




******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.043    1.705    0.045    0.000    0.233

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  1.805    1.879    2.771    2.254    1.951    4.910
                           1.762    3.475    1.126    3.011    2.304    1.282

   STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
 LATERAL DRAINAGE COLLECTED FROM LAYER  7
 ----------------------------------------
   TOTALS                  4.5527   1.6926   0.7910   0.5848   0.5234   0.3149
                           0.2889   0.3430   0.2228   0.2814   2.8655   1.1806

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER  8
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  8
 -------------------------------------
   AVERAGES                0.0367   0.0151   0.0064   0.0049   0.0042   0.0026
                           0.0023   0.0028   0.0019   0.0023   0.0239   0.0095

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           2.038   (  0.0000)      7397.05      4.630

 EVAPOTRANSPIRATION              28.531   (  0.0000)    103566.99     64.828

 LATERAL DRAINAGE COLLECTED      13.64161 (  0.00000)    49519.062   30.99663
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.009 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         -0.200   (  0.0000)      -726.90     -0.455
******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                             6.16        22360.799

      RUNOFF                                    1.705        6189.2476

      DRAINAGE COLLECTED FROM LAYER  7          0.22933       832.46790

      PERCOLATION/LEAKAGE THROUGH LAYER  8      0.000000        0.00003

      AVERAGE HEAD ON TOP OF LAYER  8           0.057

      MAXIMUM HEAD ON TOP OF LAYER  8           0.113

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)               2.9 FEET

      SNOW WATER                                0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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******************************************************************************

                FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.6051         0.2171

                  2           54.4117         0.0756

                  3            3.4554         0.2879

                  4            7.4253         0.0773

                  5           13.6183         0.2837

                  6            5.2938         0.2206

                  7            0.0022         0.0144

                  8            0.0000         0.0000

              SNOW WATER       0.000

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ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 8.5 LIFTS

Floor slope 5%

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF8-5S5.OUT


TIME:  13:46     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 8.5 LIFTS, S = 5%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  2
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =    720.00   INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                       LAYER  3
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
          THICKNESS                  =     12.00   INCHES
          POROSITY                   =      0.4530 VOL/VOL
          FIELD CAPACITY             =      0.1900 VOL/VOL
          WILTING POINT              =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2164 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                       LAYER  4
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =     96.00   INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0757 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                       LAYER  5
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
          THICKNESS                  =     48.00   INCHES
          POROSITY                   =      0.4530 VOL/VOL
          FIELD CAPACITY             =      0.1900 VOL/VOL
          WILTING POINT              =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2842 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
          THICKNESS                  =     24.00   INCHES
          POROSITY                   =      0.4570 VOL/VOL
          FIELD CAPACITY             =      0.1310 VOL/VOL
          WILTING POINT              =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2707 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                       LAYER  7
                       --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
          THICKNESS                  =      0.15   INCHES
          POROSITY                   =      0.8500 VOL/VOL
          FIELD CAPACITY             =      0.0100 VOL/VOL
          WILTING POINT              =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.3089 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
          SLOPE                      =      5.00   PERCENT
          DRAINAGE LENGTH            =    250.0    FEET


                       LAYER  8
                       --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
          THICKNESS                  =      0.06   INCHES
          POROSITY                   =      0.0000 VOL/VOL
          FIELD CAPACITY             =      0.0000 VOL/VOL
          WILTING POINT              =      0.0000 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
          FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
          FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
          FML PLACEMENT QUALITY      =  1 - PERFECT


              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     87.001  INCHES
   TOTAL INITIAL WATER                =     87.001  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                     =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX              =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =   102
        END OF GROWING SEASON (JULIAN DATE)    =   300
        EVAPORATIVE ZONE DEPTH               =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED            =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.010
                                  0.000   0.043   1.705   0.045   0.000   0.233

EVAPOTRANSPIRATION                1.805   1.879   2.771   2.254   1.951   4.910
                                  1.762   3.475   1.126   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED       4.5454  1.6902  0.7903  0.5848  0.5229  0.3149
  FROM LAYER  7                  0.2890  0.3431  0.2227  0.2810  2.8677  1.1789

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.029   0.012   0.005   0.004   0.003   0.002
  TOP OF LAYER  8                 0.002   0.002   0.001   0.002   0.019   0.008

STD. DEVIATION OF DAILY           0.011   0.003   0.001   0.001   0.001   0.000
  HEAD ON TOP OF LAYER  8         0.000   0.000   0.000   0.001   0.010   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                            44.01         159756.297    100.00

  RUNOFF                                    2.038          7397.054      4.63
```

```
  EVAPOTRANSPIRATION                     28.531       103566.992     64.83

  DRAINAGE COLLECTED FROM LAYER  7       13.6306       49479.215     30.97

  PERC./LEAKAGE THROUGH LAYER  8          0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8            0.0075

  CHANGE IN WATER STORAGE                -0.189         -686.967     -0.43

  SOIL WATER AT START OF YEAR            87.047       315980.687

  SOIL WATER AT END OF YEAR              86.858       315293.719

  SNOW WATER AT START OF YEAR             0.000            0.000      0.00

  SNOW WATER AT END OF YEAR               0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE             0.0000          -0.009      0.00

******************************************************************************




******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.010
                           0.000    0.043    1.705    0.045    0.000    0.233

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.879    2.771    2.254    1.951    4.910
                           1.762    3.475    1.126    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                4.5454   1.6902   0.7903   0.5848   0.5229   0.3149
                          0.2890   0.3431   0.2227   0.2810   2.8677   1.1789

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES              0.0293   0.0121   0.0051   0.0039   0.0034   0.0021
                          0.0019   0.0022   0.0015   0.0018   0.0191   0.0076

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------
                                     INCHES              CU. FEET      PERCENT
                               -------------------    -------------   ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          2.038   (  0.0000)       7397.05      4.630

 EVAPOTRANSPIRATION             28.531   (  0.0000)     103566.99     64.828

 LATERAL DRAINAGE COLLECTED     13.63064 (  0.00000)     49479.215   30.97169
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP             0.007 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE        -0.189   (  0.0000)       -686.97     -0.430
******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                           6.16         22360.799

      RUNOFF                                  1.705         6189.2476

      DRAINAGE COLLECTED FROM LAYER  7        0.23231        843.29980

      PERCOLATION/LEAKAGE THROUGH LAYER  8    0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  8         0.046

      MAXIMUM HEAD ON TOP OF LAYER  8         0.093

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)             0.0 FEET

      SNOW WATER                              0.77          2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

```
******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1            2.6051         0.2171

                    2           54.4117         0.0756

                    3            3.4554         0.2879

                    4            7.4253         0.0773

                    5           13.6183         0.2837

                    6            5.2938         0.2206

                    7            0.0018         0.0119

                    8            0.0000         0.0000

                SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID-HEIGHT – 8.5 LIFTS

Floor slope 6%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF8-5S6.OUT


TIME:  13:49     DATE:   6/24/2020


******************************************************************************

     TITLE:  MID FILL @ 8.5 LIFTS, S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    720.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2186 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0764 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2831 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                          LAYER  6
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
  THICKNESS                   =     24.00   INCHES
  POROSITY                    =      0.4570 VOL/VOL
  FIELD CAPACITY              =      0.1310 VOL/VOL
  WILTING POINT               =      0.0580 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2704 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                          LAYER  7
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =      0.15   INCHES
  POROSITY                    =      0.8500 VOL/VOL
  FIELD CAPACITY              =      0.0100 VOL/VOL
  WILTING POINT               =      0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2611 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
  SLOPE                       =      6.00   PERCENT
  DRAINAGE LENGTH             =    250.0    FEET


                          LAYER  8
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =      0.06   INCHES
  POROSITY                    =      0.0000 VOL/VOL
  FIELD CAPACITY              =      0.0000 VOL/VOL
  WILTING POINT               =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY       =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
       SCS RUNOFF CURVE NUMBER             =     86.00
       FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
       INITIAL SNOW WATER                  =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS    =     87.027  INCHES
       TOTAL INITIAL WATER                 =     87.027  INCHES
       TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                   EVAPOTRANSPIRATION AND WEATHER DATA
                   -----------------------------------

        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 BALTIMORE             MARYLAND

            STATION LATITUDE                        =  39.18 DEGREES
            MAXIMUM LEAF AREA INDEX                 =   0.00
            START OF GROWING SEASON (JULIAN DATE)   =    102
            END OF GROWING SEASON (JULIAN DATE)     =    300
            EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
            AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                   2.00    1.42    3.53    1.61    2.69    4.35
                                2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                          0.000   0.000   0.000   0.000   0.000   0.010
                                0.000   0.046   1.706   0.046   0.000   0.253

EVAPOTRANSPIRATION              1.804   1.891   2.770   2.246   1.962   4.890
                                1.762   3.477   1.127   3.025   2.302   1.281

LATERAL DRAINAGE COLLECTED      4.5562  1.7001  0.7933  0.5838  0.5230  0.3116
  FROM LAYER  7                 0.2844  0.3508  0.2161  0.2750  2.8554  1.1841

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.025   0.010   0.004   0.003   0.003   0.002
  TOP OF LAYER  8               0.002   0.002   0.001   0.001   0.016   0.006

STD. DEVIATION OF DAILY         0.009   0.003   0.001   0.000   0.001   0.000
  HEAD ON TOP OF LAYER  8       0.000   0.000   0.000   0.001   0.009   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
                                         --------       ----------    -------
  PRECIPITATION                            44.01        159756.297    100.00

  RUNOFF                                    2.063         7488.505      4.69
```

```
  EVAPOTRANSPIRATION                    28.539       103595.297     64.85

  DRAINAGE COLLECTED FROM LAYER  7      13.6338       49490.711     30.98

  PERC./LEAKAGE THROUGH LAYER  8         0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8           0.0063

  CHANGE IN WATER STORAGE               -0.225         -818.212     -0.51

  SOIL WATER AT START OF YEAR           87.066       316050.594

  SOIL WATER AT END OF YEAR             86.841       315232.375

  SNOW WATER AT START OF YEAR            0.000            0.000      0.00

  SNOW WATER AT END OF YEAR              0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000          -0.012      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  2.00     1.42     3.53     1.61     2.69     4.35
                            2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS         0.00     0.00     0.00     0.00     0.00     0.00
                            0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                  0.000    0.000    0.000    0.000    0.000    0.010
                            0.000    0.046    1.706    0.046    0.000    0.253

    STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                  1.804    1.891    2.770    2.246    1.962    4.890
                            1.762    3.477    1.127    3.025    2.302    1.281

    STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                  4.5562   1.7001   0.7933   0.5838   0.5230   0.3116
                            0.2844   0.3508   0.2161   0.2750   2.8554   1.1841

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES                0.0245   0.0101   0.0043   0.0032   0.0028   0.0017
                            0.0015   0.0019   0.0012   0.0015   0.0159   0.0064

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES            CU. FEET     PERCENT
                                -------------------   -------------  ---------
 PRECIPITATION                    44.01    (   0.000)   159756.3     100.00

 RUNOFF                            2.063   (  0.0000)     7488.51      4.687

 EVAPOTRANSPIRATION               28.539   (  0.0000)   103595.30     64.846

 LATERAL DRAINAGE COLLECTED       13.63380 (  0.00000)    49490.711   30.97888
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH       0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP               0.006 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          -0.225   (  0.0000)     -818.21     -0.512

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                            6.16        22360.799

      RUNOFF                                   1.706        6193.2847

      DRAINAGE COLLECTED FROM LAYER  7         0.23206       842.37317

      PERCOLATION/LEAKAGE THROUGH LAYER  8     0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  8          0.039

      MAXIMUM HEAD ON TOP OF LAYER  8          0.075

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)              6.7 FEET

      SNOW WATER                               0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


******************************************************************************
```

```
******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)        (VOL/VOL)
                 -----        --------        ---------
                   1           2.6243          0.2187

                   2          54.8452          0.0762

                   3           3.3828          0.2819

                   4           7.1743          0.0747

                   5          13.4217          0.2796

                   6           5.3481          0.2228

                   7           0.0052          0.0349

                   8           0.0000          0.0000

               SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

MID -HEIGHT – 8.5 LIFTS

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**                HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**               FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\MF8-5S33.OUT


TIME:  11:23     DATE:   6/26/2020


******************************************************************************

     TITLE:  MID FILL @ 8.5 LIFTS; S = 33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  2
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
         THICKNESS                  =    528.00   INCHES
         POROSITY                   =      0.1680 VOL/VOL
         FIELD CAPACITY             =      0.0730 VOL/VOL
         WILTING POINT              =      0.0190 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  3
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
         THICKNESS                  =     12.00   INCHES
         POROSITY                   =      0.4530 VOL/VOL
         FIELD CAPACITY             =      0.1900 VOL/VOL
         WILTING POINT              =      0.0850 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.2221 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                       LAYER  4
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
         THICKNESS                  =     96.00   INCHES
         POROSITY                   =      0.1680 VOL/VOL
         FIELD CAPACITY             =      0.0730 VOL/VOL
         WILTING POINT              =      0.0190 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.0782 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  5
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
         THICKNESS                  =     48.00   INCHES
         POROSITY                   =      0.4530 VOL/VOL
         FIELD CAPACITY             =      0.1900 VOL/VOL
         WILTING POINT              =      0.0850 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.2814 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
         THICKNESS                  =     24.00   INCHES
         POROSITY                   =      0.4570 VOL/VOL
         FIELD CAPACITY             =      0.1310 VOL/VOL
         WILTING POINT              =      0.0580 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.2791 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                       LAYER  7
                       --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
         THICKNESS                  =      0.15   INCHES
         POROSITY                   =      0.8500 VOL/VOL
         FIELD CAPACITY             =      0.0100 VOL/VOL
         WILTING POINT              =      0.0050 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.0269 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
         SLOPE                      =     33.00   PERCENT
         DRAINAGE LENGTH            =     75.0    FEET


                       LAYER  8
                       --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
         THICKNESS                  =      0.06   INCHES
         POROSITY                   =      0.0000 VOL/VOL
         FIELD CAPACITY             =      0.0000 VOL/VOL
         WILTING POINT              =      0.0000 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
         FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
         FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
         FML PLACEMENT QUALITY      =  1 - PERFECT


             GENERAL DESIGN AND EVAPORATIVE ZONE DATA
             ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.
```

```
   SCS RUNOFF CURVE NUMBER             =     86.00
   FRACTION OF AREA ALLOWING RUNOFF    =     50.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                  =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     72.838  INCHES
   TOTAL INITIAL WATER                 =     72.838  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60
```

```
         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.001   0.000   0.000   0.000   0.000   0.011
                                 0.000   0.055   1.652   0.046   0.002   0.332

EVAPOTRANSPIRATION               1.825   1.860   2.422   2.070   1.747   4.392
                                 1.480   3.464   0.920   3.065   2.340   1.287

LATERAL DRAINAGE COLLECTED       4.5609  1.5614  0.8036  0.5683  0.3514  0.4580
  FROM LAYER  7                  0.5124  0.2748  0.3498  1.2149  3.4135  1.1621

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  8                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.001   0.001   0.000   0.000   0.000   0.000
  TOP OF LAYER  8                0.000   0.000   0.000   0.000   0.001   0.000

STD. DEVIATION OF DAILY          0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  8        0.000   0.000   0.000   0.000   0.001   0.000

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                            44.01         159756.297    100.00

  RUNOFF                                    2.100          7622.630      4.77
```

```
  EVAPOTRANSPIRATION                  26.873        97548.234     61.06

  DRAINAGE COLLECTED FROM LAYER  7    15.2312       55289.234     34.61

  PERC./LEAKAGE THROUGH LAYER  8       0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8         0.0004

  CHANGE IN WATER STORAGE             -0.194         -703.861     -0.44

  SOIL WATER AT START OF YEAR         72.842       264416.531

  SOIL WATER AT END OF YEAR           72.648       263712.656

  SNOW WATER AT START OF YEAR          0.000            0.000      0.00

  SNOW WATER AT END OF YEAR            0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE          0.0000           0.048      0.00

*******************************************************************************




*******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.001    0.000    0.000    0.000    0.000    0.011
                           0.000    0.055    1.652    0.046    0.002    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.825    1.860    2.422    2.070    1.747    4.392
                           1.480    3.464    0.920    3.065    2.340    1.287

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000
```

```
  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                4.5609   1.5614   0.8036   0.5683   0.3514   0.4580
                          0.5124   0.2748   0.3498   1.2149   3.4135   1.1621

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  8
  ------------------------------------
    TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES              0.0015   0.0006   0.0003   0.0002   0.0001   0.0002
                          0.0002   0.0001   0.0001   0.0004   0.0011   0.0004

    STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                       INCHES             CU. FEET     PERCENT
                               -------------------    -------------  ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           2.100   (  0.0000)      7622.63      4.771

 EVAPOTRANSPIRATION              26.873   (  0.0000)     97548.23     61.061

 LATERAL DRAINAGE COLLECTED      15.23119 (  0.00000)    55289.234   34.60849
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER  8

 AVERAGE HEAD ON TOP              0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         -0.194   (  0.0000)      -703.86     -0.441

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                            6.16        22360.799

      RUNOFF                                   1.652        5996.8691

      DRAINAGE COLLECTED FROM LAYER  7         0.27590      1001.53326

      PERCOLATION/LEAKAGE THROUGH LAYER  8     0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  8          0.003

      MAXIMUM HEAD ON TOP OF LAYER  8          0.005

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)              0.0 FEET

      SNOW WATER                               0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.3770

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1            2.6622         0.2218

                   2           40.6901         0.0771

                   3            3.3795         0.2816

                   4            7.3393         0.0765

                   5           13.2675         0.2764

                   6            5.3036         0.2210

                   7            0.0019         0.0125

                   8            0.0000         0.0000

               SNOW WATER       0.000

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```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – FIVE LIFTS

Floor slope 2%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\FF5S2.OUT


TIME:  18:46     DATE:   7/ 7/2020


******************************************************************************

     TITLE:  FULL FILL @5 LIFTS; S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
            WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    240.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2131 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    144.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0764 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2953 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0770 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2934 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2553 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0110 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
```

```
      SLOPE                       =      2.00   PERCENT
      DRAINAGE LENGTH             =    250.0    FEET


                        LAYER 10
                        --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
      THICKNESS                   =      0.06   INCHES
      POROSITY                    =      0.0000 VOL/VOL
      FIELD CAPACITY              =      0.0000 VOL/VOL
      WILTING POINT               =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
      FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
      FML PLACEMENT QUALITY       =  1 - PERFECT



              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     65.418  INCHES
   TOTAL INITIAL WATER                =     65.418  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  62.00 %
```

```
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.015
                                 0.000   0.060   2.600   0.069   0.001   0.332

EVAPOTRANSPIRATION               1.811   1.893   2.700   2.247   1.953   4.919
                                 1.729   3.442   1.131   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED      4.9051  1.4461  0.9416  0.4864  0.5786  0.3905
  FROM LAYER  9                 0.3082  0.2732  0.3215  0.2786  1.7875  1.1426
```

```
PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.165   0.026   0.015   0.008   0.009   0.006
  TOP OF LAYER 10                0.005   0.004   0.005   0.004   0.030   0.018

STD. DEVIATION OF DAILY          0.493   0.007   0.003   0.002   0.001   0.001
  HEAD ON TOP OF LAYER 10        0.000   0.001   0.002   0.002   0.017   0.006

*******************************************************************************


*******************************************************************************

                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                       INCHES          CU. FEET     PERCENT
                                      --------        ----------    -------
  PRECIPITATION                         44.01         159756.297    100.00

  RUNOFF                                 3.077         11168.417      6.99

  EVAPOTRANSPIRATION                    28.424        103179.672     64.59

  DRAINAGE COLLECTED FROM LAYER  9      12.8598        46681.000     29.22

  PERC./LEAKAGE THROUGH LAYER 10         0.000003          0.010      0.00

  AVG. HEAD ON TOP OF LAYER 10           0.0248

  CHANGE IN WATER STORAGE               -0.351          -1272.821    -0.80

  SOIL WATER AT START OF YEAR           65.420        237474.781

  SOIL WATER AT END OF YEAR             65.069        236201.969

  SNOW WATER AT START OF YEAR            0.000             0.000      0.00

  SNOW WATER AT END OF YEAR              0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000            0.016      0.00

*******************************************************************************



*******************************************************************************
```

```
       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.015
                           0.000    0.060    2.600    0.069    0.001    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.811    1.893    2.700    2.247    1.953    4.919
                           1.729    3.442    1.131    3.011    2.305    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.9051   1.4461   0.9416   0.4864   0.5786   0.3905
                           0.3082   0.2732   0.3215   0.2786   1.7875   1.1426

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.1653   0.0258   0.0152   0.0081   0.0093   0.0065
                           0.0050   0.0044   0.0053   0.0045   0.0297   0.0184

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES           CU. FEET       PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           3.077   (  0.0000)      11168.42      6.991

 EVAPOTRANSPIRATION              28.424   (  0.0000)     103179.67     64.586

 LATERAL DRAINAGE COLLECTED      12.85978 (  0.00000)     46681.000   29.22013
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.010     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP              0.025 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE         -0.351   (  0.0000)      -1272.82     -0.797

*******************************************************************************
```

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*******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                                   (INCHES)      (CU. FT.)
                                                  ----------    -------------
     PRECIPITATION                                  6.16         22360.799

     RUNOFF                                         2.600         9439.0186

     DRAINAGE COLLECTED FROM LAYER  9               0.28407       1031.15833

     PERCOLATION/LEAKAGE THROUGH LAYER 10           0.000000         0.00116

     AVERAGE HEAD ON TOP OF LAYER 10                2.818

     MAXIMUM HEAD ON TOP OF LAYER 10                4.487

     LOCATION OF MAXIMUM HEAD IN LAYER  9
           (DISTANCE FROM DRAIN)                   38.5 FEET

     SNOW WATER                                     0.77          2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                   LAYER        (INCHES)       (VOL/VOL)
                   -----        --------       ---------
                     1            2.5515         0.2126

                     2           18.4037         0.0767

                     3            3.5210         0.2934

                     4           11.1676         0.0776

                     5            3.4971         0.2914

                     6            7.8630         0.0819

                     7           12.6868         0.2643

                     8            5.3622         0.2234

                     9            0.0147         0.0980

                    10            0.0000         0.0000

                  SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

FULL -HEIGHT – FIVE LIFTS

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF5S3.OUT


TIME:  18:49     DATE:   7/ 7/2020


******************************************************************************

     TITLE:  FULL FILL @5 LIFTS; S = 3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =    240.00   INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2131 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =    144.00   INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0764 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  5
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2953 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0770 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  7
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2934 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC



                        LAYER  8
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2553 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                        LAYER  9
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0110 VOL/VOL
```

```
   EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
   SLOPE                      =      3.00   PERCENT
   DRAINAGE LENGTH            =    250.0    FEET



                           LAYER 10
                           --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =      0.06   INCHES
   POROSITY                   =      0.0000 VOL/VOL
   FIELD CAPACITY             =      0.0000 VOL/VOL
   WILTING POINT              =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
   FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
   FML PLACEMENT QUALITY      =  1 - PERFECT



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER            =     86.00
FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =     65.418  INCHES
TOTAL INITIAL WATER                =     65.418  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

    STATION LATITUDE                        =  39.18 DEGREES
    MAXIMUM LEAF AREA INDEX                 =   0.00
    START OF GROWING SEASON (JULIAN DATE)   =    102
    END OF GROWING SEASON (JULIAN DATE)     =    300
    EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
    AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
```

```
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        3.47        3.02        3.93        3.00        3.89        3.43
        3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       32.40       35.50       43.70       53.20       62.80       71.70
       76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.015
                                 0.000   0.060   2.600   0.069   0.001   0.332

EVAPOTRANSPIRATION               1.811   1.893   2.700   2.247   1.953   4.919
                                 1.729   3.442   1.131   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED      4.9167  1.4402  0.9392  0.4850  0.5792  0.3895
```

```
  FROM LAYER  9                 0.3079  0.2733  0.3210  0.2798  1.7929  1.1425

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.053   0.017   0.010   0.005   0.006   0.004
  TOP OF LAYER 10                0.003   0.003   0.004   0.003   0.020   0.012

STD. DEVIATION OF DAILY          0.021   0.004   0.002   0.001   0.001   0.001
  HEAD ON TOP OF LAYER 10        0.000   0.000   0.001   0.001   0.011   0.004

*******************************************************************************



*******************************************************************************

                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
                                         --------       ----------    -------
  PRECIPITATION                            44.01        159756.297    100.00

  RUNOFF                                    3.077        11168.417      6.99

  EVAPOTRANSPIRATION                       28.424       103179.672     64.59

  DRAINAGE COLLECTED FROM LAYER  9         12.8672       46708.004     29.24

  PERC./LEAKAGE THROUGH LAYER 10            0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10              0.0117

  CHANGE IN WATER STORAGE                  -0.358        -1299.823     -0.81

  SOIL WATER AT START OF YEAR              65.420       237474.781

  SOIL WATER AT END OF YEAR                65.062       236174.969

  SNOW WATER AT START OF YEAR               0.000            0.000      0.00

  SNOW WATER AT END OF YEAR                 0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE               0.0000           0.013      0.00

*******************************************************************************
```

```
******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.015
                           0.000    0.060    2.600    0.069    0.001    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.811    1.893    2.700    2.247    1.953    4.919
                           1.729    3.442    1.131    3.011    2.305    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.9167   1.4402   0.9392   0.4850   0.5792   0.3895
                           0.3079   0.2733   0.3210   0.2798   1.7929   1.1425

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0528   0.0171   0.0101   0.0054   0.0062   0.0043
                           0.0033   0.0029   0.0036   0.0030   0.0199   0.0123
```

```
    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                                      INCHES             CU. FEET      PERCENT
                               -------------------    -------------   ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           3.077   (  0.0000)      11168.42      6.991

 EVAPOTRANSPIRATION              28.424   (  0.0000)     103179.67     64.586

 LATERAL DRAINAGE COLLECTED      12.86722 (  0.00000)     46708.004   29.23704
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.009    0.00001
   LAYER 10

 AVERAGE HEAD ON TOP              0.012 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE         -0.358   (  0.0000)      -1299.82     -0.814

******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                            (INCHES)      (CU. FT.)
                                           ----------   -------------
     PRECIPITATION                            6.16        22360.799

     RUNOFF                                   2.600        9439.0186

     DRAINAGE COLLECTED FROM LAYER  9         0.29491      1070.51770

     PERCOLATION/LEAKAGE THROUGH LAYER 10     0.000000        0.00004

     AVERAGE HEAD ON TOP OF LAYER 10          0.098

     MAXIMUM HEAD ON TOP OF LAYER 10          0.194

     LOCATION OF MAXIMUM HEAD IN LAYER  9
           (DISTANCE FROM DRAIN)              2.4 FEET

     SNOW WATER                               0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

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******************************************************************************

                FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.5515         0.2126

                  2           18.4037         0.0767

                  3            3.5210         0.2934

                  4           11.1676         0.0776

                  5            3.4971         0.2914

                  6            7.8630         0.0819

                  7           12.6868         0.2643

                  8            5.3622         0.2234

                  9            0.0073         0.0484

                 10            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
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```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – FIVE LIFTS

Floor slope 4%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\FF5S4.OUT


TIME:  18:52     DATE:   7/ 7/2020


******************************************************************************

     TITLE:  FULL FILL @5 LIFTS; S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =    12.00   INCHES
           POROSITY                     =     0.4530 VOL/VOL
           FIELD CAPACITY               =     0.1900 VOL/VOL
           WILTING POINT                =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =     0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    240.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2171 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =    144.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0760 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2945 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                  =     96.00   INCHES
POROSITY                   =      0.1680 VOL/VOL
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0775 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                  =     48.00   INCHES
POROSITY                   =      0.4530 VOL/VOL
FIELD CAPACITY             =      0.1900 VOL/VOL
WILTING POINT              =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2934 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2543 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.15   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0101 VOL/VOL
```

```
      EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
      SLOPE                       =      4.00   PERCENT
      DRAINAGE LENGTH             =    250.0    FEET


                        LAYER 10
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
      THICKNESS                   =      0.06   INCHES
      POROSITY                    =      0.0000 VOL/VOL
      FIELD CAPACITY              =      0.0000 VOL/VOL
      WILTING POINT               =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
      FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
      FML PLACEMENT QUALITY       =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     65.423  INCHES
   TOTAL INITIAL WATER                =     65.423  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE              MARYLAND

        STATION LATITUDE                       =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    102
        END OF GROWING SEASON (JULIAN DATE)    =    300
        EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
```

```
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   3.47        3.02        3.93        3.00        3.89        3.43
   3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   32.40       35.50       43.70       53.20       62.80       71.70
   76.50       74.50       67.40       55.30       45.50       36.60


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND
               AND STATION LATITUDE  =  39.18 DEGREES



*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                  2.00    1.42    3.53    1.61    2.69    4.35
                               2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                         0.000   0.000   0.000   0.000   0.000   0.016
                               0.000   0.064   2.589   0.068   0.001   0.353

EVAPOTRANSPIRATION             1.805   1.880   2.771   2.254   1.951   4.909
                               1.762   3.476   1.136   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED     4.8789  1.4629  0.9477  0.4872  0.5771  0.3935
```

```
  FROM LAYER  9                 0.3127  0.2958  0.2898  0.2521  1.6586  1.1702

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.039   0.013   0.008   0.004   0.005   0.003
  TOP OF LAYER 10               0.003   0.002   0.002   0.002   0.014   0.009

STD. DEVIATION OF DAILY         0.015   0.003   0.002   0.001   0.000   0.000
  HEAD ON TOP OF LAYER 10       0.000   0.000   0.000   0.001   0.009   0.003

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES         CU. FEET     PERCENT
                                        --------       ----------    -------
  PRECIPITATION                          44.01         159756.297    100.00

  RUNOFF                                  3.091         11220.854      7.02

  EVAPOTRANSPIRATION                     28.542        103606.211     64.85

  DRAINAGE COLLECTED FROM LAYER  9       12.7264        46196.918     28.92

  PERC./LEAKAGE THROUGH LAYER 10          0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10            0.0087

  CHANGE IN WATER STORAGE                -0.349         -1267.725     -0.79

  SOIL WATER AT START OF YEAR            65.425        237491.266

  SOIL WATER AT END OF YEAR              65.075        236223.547

  SNOW WATER AT START OF YEAR             0.000             0.000      0.00

  SNOW WATER AT END OF YEAR               0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE             0.0000            0.026      0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.016
                           0.000    0.064    2.589    0.068    0.001    0.353

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.880    2.771    2.254    1.951    4.909
                           1.762    3.476    1.136    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8789   1.4629   0.9477   0.4872   0.5771   0.3935
                           0.3127   0.2958   0.2898   0.2521   1.6586   1.1702

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0393   0.0131   0.0076   0.0041   0.0047   0.0033
                           0.0025   0.0024   0.0024   0.0020   0.0138   0.0094
```

```
   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                   INCHES            CU. FEET      PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                 44.01    (   0.000)    159756.3     100.00

 RUNOFF                          3.091   (  0.0000)     11220.85      7.024

 EVAPOTRANSPIRATION            28.542   (  0.0000)    103606.21     64.853

 LATERAL DRAINAGE COLLECTED     12.72642 (  0.00000)    46196.918   28.91712
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.009     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP             0.009 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE        -0.349   (  0.0000)     -1267.72     -0.794

*******************************************************************************
```

```
*******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
   PRECIPITATION                                    6.16        22360.799

   RUNOFF                                           2.589        9398.5059

   DRAINAGE COLLECTED FROM LAYER  9                 0.28312      1027.72229

   PERCOLATION/LEAKAGE THROUGH LAYER 10             0.000000        0.00003

   AVERAGE HEAD ON TOP OF LAYER 10                  0.071

   MAXIMUM HEAD ON TOP OF LAYER 10                  0.140

   LOCATION OF MAXIMUM HEAD IN LAYER  9
         (DISTANCE FROM DRAIN)                      2.4 FEET

   SNOW WATER                                       0.77         2798.9209


   MAXIMUM VEG. SOIL WATER (VOL/VOL)                        0.4530

   MINIMUM VEG. SOIL WATER (VOL/VOL)                        0.0850

    ***  Maximum heads are computed using McEnroe's equations.  ***

         Reference:  Maximum Saturated Depth over Landfill Liner
                     by Bruce M. McEnroe, University of Kansas
                     ASCE Journal of Environmental Engineering
                     Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
*******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
               LAYER         (INCHES)       (VOL/VOL)
               -----         --------       ---------
                 1             2.6121         0.2177

                 2            18.3020         0.0763

                 3             3.4908         0.2909

                 4            11.2310         0.0780

                 5             3.5648         0.2971

                 6             7.8654         0.0819

                 7            12.6277         0.2631

                 8             5.3686         0.2237

                 9             0.0115         0.0765

                10             0.0000         0.0000

              SNOW WATER       0.000

*******************************************************************************
*******************************************************************************
```

HELP MODEL PRINTOUTS

FULL -HEIGHT – FIVE LIFTS

Floor slope 5%

```
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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF5S5.OUT


TIME:  18:54     DATE:   7/ 7/2020


******************************************************************************

     TITLE:  FULL FILL @5 LIFTS; S = 5%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =   240.00   INCHES
           POROSITY                   =     0.1680 VOL/VOL
           FIELD CAPACITY             =     0.0730 VOL/VOL
           WILTING POINT              =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.0755 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2171 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =   144.00   INCHES
           POROSITY                   =     0.1680 VOL/VOL
           FIELD CAPACITY             =     0.0730 VOL/VOL
           WILTING POINT              =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.0760 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  5
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2945 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  19
     THICKNESS                 =     96.00   INCHES
     POROSITY                  =      0.1680 VOL/VOL
     FIELD CAPACITY            =      0.0730 VOL/VOL
     WILTING POINT             =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0775 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                       LAYER  7
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   6
     THICKNESS                 =     48.00   INCHES
     POROSITY                  =      0.4530 VOL/VOL
     FIELD CAPACITY            =      0.1900 VOL/VOL
     WILTING POINT             =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2934 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                       LAYER  8
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
     THICKNESS                 =     24.00   INCHES
     POROSITY                  =      0.4570 VOL/VOL
     FIELD CAPACITY            =      0.1310 VOL/VOL
     WILTING POINT             =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2543 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                       LAYER  9
                       --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
     THICKNESS                 =      0.15   INCHES
     POROSITY                  =      0.8500 VOL/VOL
     FIELD CAPACITY            =      0.0100 VOL/VOL
     WILTING POINT             =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0101 VOL/VOL
```

```
     EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
     SLOPE                       =      5.00   PERCENT
     DRAINAGE LENGTH             =    250.0    FEET


                       LAYER 10
                       --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
     THICKNESS                 =      0.06   INCHES
     POROSITY                  =      0.0000 VOL/VOL
     FIELD CAPACITY            =      0.0000 VOL/VOL
     WILTING POINT             =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
     FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
     FML PLACEMENT QUALITY       =  1 - PERFECT


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

  SCS RUNOFF CURVE NUMBER            =     86.00
  FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
  AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
  EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
  INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
  UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
  LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
  INITIAL SNOW WATER                 =      0.000  INCHES
  INITIAL WATER IN LAYER MATERIALS    =     65.423  INCHES
  TOTAL INITIAL WATER                =     65.423  INCHES
  TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           BALTIMORE             MARYLAND

       STATION LATITUDE                     =  39.18 DEGREES
       MAXIMUM LEAF AREA INDEX              =   0.00
       START OF GROWING SEASON (JULIAN DATE)  =    102
       END OF GROWING SEASON (JULIAN DATE)    =    300
       EVAPORATIVE ZONE DEPTH               =   9.0  INCHES
       AVERAGE ANNUAL WIND SPEED            =   9.30 MPH
```

```
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        3.47        3.02        3.93        3.00        3.89        3.43
        3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       32.40       35.50       43.70       53.20       62.80       71.70
       76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.016
                                 0.000   0.064   2.589   0.068   0.001   0.353

EVAPOTRANSPIRATION               1.805   1.880   2.771   2.254   1.951   4.909
                                 1.762   3.476   1.136   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED      4.8825  1.4610  0.9467  0.4871  0.5772  0.3931
```

```
  FROM LAYER  9                 0.3126  0.2959  0.2897  0.2525  1.6601  1.1701

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.032   0.010   0.006   0.003   0.004   0.003
  TOP OF LAYER 10               0.002   0.002   0.002   0.002   0.011   0.008

STD. DEVIATION OF DAILY         0.012   0.003   0.001   0.001   0.000   0.000
  HEAD ON TOP OF LAYER 10       0.000   0.000   0.000   0.001   0.007   0.002

*******************************************************************************


*******************************************************************************

                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                      INCHES         CU. FEET     PERCENT
                                     --------       ----------    -------
  PRECIPITATION                        44.01        159756.297    100.00

  RUNOFF                                3.091        11220.854      7.02

  EVAPOTRANSPIRATION                   28.542       103606.211     64.85

  DRAINAGE COLLECTED FROM LAYER  9     12.7286       46204.820     28.92

  PERC./LEAKAGE THROUGH LAYER 10        0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10          0.0070

  CHANGE IN WATER STORAGE              -0.351        -1275.646     -0.80

  SOIL WATER AT START OF YEAR          65.425       237491.266

  SOIL WATER AT END OF YEAR            65.073       236215.625

  SNOW WATER AT START OF YEAR           0.000            0.000      0.00

  SNOW WATER AT END OF YEAR             0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE           0.0000           0.043      0.00

*******************************************************************************
```

```
******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.016
                           0.000    0.064    2.589    0.068    0.001    0.353

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.880    2.771    2.254    1.951    4.909
                           1.762    3.476    1.136    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8825   1.4610   0.9467   0.4871   0.5772   0.3931
                           0.3126   0.2959   0.2897   0.2525   1.6601   1.1701

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0315   0.0104   0.0061   0.0032   0.0037   0.0026
                           0.0020   0.0019   0.0019   0.0016   0.0111   0.0076
```

```
    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

******************************************************************************


******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------------

                                      INCHES            CU. FEET     PERCENT
                               -------------------    -------------  ---------
 PRECIPITATION                   44.01    (   0.000)     159756.3     100.00

 RUNOFF                           3.091   (  0.0000)      11220.85      7.024

 EVAPOTRANSPIRATION              28.542   (  0.0000)     103606.21     64.853

 LATERAL DRAINAGE COLLECTED      12.72860 (  0.00000)     46204.820   28.92207
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)         0.009    0.00001
   LAYER 10

 AVERAGE HEAD ON TOP              0.007 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE         -0.351   (  0.0000)      -1275.65     -0.798

******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                           (INCHES)      (CU. FT.)
                                          ----------   -------------
     PRECIPITATION                           6.16        22360.799

     RUNOFF                                  2.589         9398.5059

     DRAINAGE COLLECTED FROM LAYER  9        0.28329       1028.34924

     PERCOLATION/LEAKAGE THROUGH LAYER 10    0.000000         0.00003

     AVERAGE HEAD ON TOP OF LAYER 10         0.057

     MAXIMUM HEAD ON TOP OF LAYER 10         0.112

     LOCATION OF MAXIMUM HEAD IN LAYER  9
           (DISTANCE FROM DRAIN)             3.1 FEET

     SNOW WATER                              0.77          2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

     MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.6121         0.2177

                  2           18.3020         0.0763

                  3            3.4908         0.2909

                  4           11.2310         0.0780

                  5            3.5648         0.2971

                  6            7.8654         0.0819

                  7           12.6277         0.2631

                  8            5.3686         0.2237

                  9            0.0093         0.0620

                 10            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – FIVE LIFTS

Floor slope 6%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
**               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                    USAE WATERWAYS EXPERIMENT STATION                    **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF5S6.OUT


TIME:  18:57     DATE:   7/ 7/2020


******************************************************************************

     TITLE:  FULL FILL @5 LIFTS; S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   6
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4530 VOL/VOL
           FIELD CAPACITY               =      0.1900 VOL/VOL
           WILTING POINT                =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    240.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2187 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    144.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0774 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2965 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0747 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2980 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2448 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
```

```
          EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
          SLOPE                       =      6.00   PERCENT
          DRAINAGE LENGTH             =    250.0    FEET


                                  LAYER 10
                                  --------

                      TYPE 4 - FLEXIBLE MEMBRANE LINER
                        MATERIAL TEXTURE NUMBER  35
          THICKNESS                   =      0.06   INCHES
          POROSITY                    =      0.0000 VOL/VOL
          FIELD CAPACITY              =      0.0000 VOL/VOL
          WILTING POINT               =      0.0000 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
          FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
          FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
          FML PLACEMENT QUALITY       =  1 - PERFECT



                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                 ----------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

       SCS RUNOFF CURVE NUMBER            =     86.00
       FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
       INITIAL SNOW WATER                 =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS   =     65.392  INCHES
       TOTAL INITIAL WATER                =     65.392  INCHES
       TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


                  EVAPOTRANSPIRATION AND WEATHER DATA
                  -----------------------------------

        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 BALTIMORE            MARYLAND

            STATION LATITUDE                        =  39.18 DEGREES
            MAXIMUM LEAF AREA INDEX                 =   0.00
            START OF GROWING SEASON (JULIAN DATE)   =    102
            END OF GROWING SEASON (JULIAN DATE)     =    300
            EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
            AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
```

```
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     3.47        3.02        3.93        3.00        3.89        3.43
     3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

            NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     32.40       35.50       43.70       53.20       62.80       71.70
     76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                              JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                              ------- ------- ------- ------- ------- -------

PRECIPITATION                  2.00    1.42    3.53    1.61    2.69    4.35
                               2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                         0.001   0.000   0.000   0.000   0.000   0.016
                               0.000   0.070   2.562   0.069   0.001   0.385

EVAPOTRANSPIRATION             1.804   1.891   2.770   2.244   1.962   4.893
                               1.762   3.479   1.128   3.025   2.302   1.281

LATERAL DRAINAGE COLLECTED     4.8052  1.4964  0.9528  0.4892  0.5756  0.3944
```

```
  FROM LAYER  9                 0.3123  0.2851  0.2977  0.2493  1.6604  1.1780

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.026   0.009   0.005   0.003   0.003   0.002
  TOP OF LAYER 10               0.002   0.002   0.002   0.001   0.009   0.006

STD. DEVIATION OF DAILY         0.012   0.002   0.001   0.001   0.000   0.000
  HEAD ON TOP OF LAYER 10       0.000   0.000   0.000   0.001   0.006   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           44.01         159756.297    100.00

  RUNOFF                                   3.103         11263.241      7.05

  EVAPOTRANSPIRATION                      28.542        103605.773     64.85

  DRAINAGE COLLECTED FROM LAYER  9        12.6962        46087.301     28.85

  PERC./LEAKAGE THROUGH LAYER 10           0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10             0.0058

  CHANGE IN WATER STORAGE                 -0.331         -1200.067     -0.75

  SOIL WATER AT START OF YEAR             65.393        237377.906

  SOIL WATER AT END OF YEAR               65.063        236177.844

  SNOW WATER AT START OF YEAR              0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000            0.033      0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.001    0.000    0.000    0.000    0.000    0.016
                           0.000    0.070    2.562    0.069    0.001    0.385

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.804    1.891    2.770    2.244    1.962    4.893
                           1.762    3.479    1.128    3.025    2.302    1.281

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8052   1.4964   0.9528   0.4892   0.5756   0.3944
                           0.3123   0.2851   0.2977   0.2493   1.6604   1.1780

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0259   0.0089   0.0051   0.0027   0.0031   0.0022
                           0.0017   0.0015   0.0017   0.0013   0.0092   0.0063
```

```
   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                    INCHES            CU. FEET       PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          3.103   (  0.0000)      11263.24      7.050

 EVAPOTRANSPIRATION             28.542   (  0.0000)     103605.77     64.852

 LATERAL DRAINAGE COLLECTED     12.69623 (  0.00000)     46087.301   28.84850
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP             0.006 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE        -0.331   (  0.0000)      -1200.07     -0.751
*******************************************************************************
```

```
*******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                                    (INCHES)      (CU. FT.)
                                                   ----------   -------------
      PRECIPITATION                                   6.16        22360.799

      RUNOFF                                          2.562        9301.0596

      DRAINAGE COLLECTED FROM LAYER  9                0.30182      1095.60193

      PERCOLATION/LEAKAGE THROUGH LAYER 10            0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER 10                 0.050

      MAXIMUM HEAD ON TOP OF LAYER 10                 0.101

      LOCATION OF MAXIMUM HEAD IN LAYER  9
            (DISTANCE FROM DRAIN)                     0.0 FEET

      SNOW WATER                                      0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                       0.4501

      MINIMUM VEG. SOIL WATER (VOL/VOL)                       0.0850

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


*******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.6247         0.2187

                  2           18.5408         0.0773

                  3            3.4967         0.2914

                  4           11.1363         0.0773

                  5            3.5829         0.2986

                  6            7.7993         0.0812

                  7           12.4904         0.2602

                  8            5.3857         0.2244

                  9            0.0045         0.0297

                 10            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

HELP MODEL PRINTOUTS

FULL -HEIGHT – FIVE LIFTS

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF5S33.OUT


TIME:  11:54     DATE:   6/26/2020


******************************************************************************

     TITLE:  FULL FILL @5 LIFTS, S = 33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =   240.00   INCHES
           POROSITY                   =     0.1680 VOL/VOL
           FIELD CAPACITY             =     0.0730 VOL/VOL
           WILTING POINT              =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.0755 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2218 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =   144.00   INCHES
           POROSITY                   =     0.1680 VOL/VOL
           FIELD CAPACITY             =     0.0730 VOL/VOL
           WILTING POINT              =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.0782 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                   LAYER  5
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =    12.00   INCHES
           POROSITY                   =     0.4530 VOL/VOL
           FIELD CAPACITY             =     0.1900 VOL/VOL
           WILTING POINT              =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2950 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0751 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                       LAYER  7
                       --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2999 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC



                       LAYER  8
                       --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2288 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                       LAYER  9
                       --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0125 VOL/VOL
```

```
EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
SLOPE                       =     33.00   PERCENT
DRAINAGE LENGTH             =     75.0    FEET



                       LAYER 10
                       --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER            =     86.00
FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
INITIAL SNOW WATER                 =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =     65.272  INCHES
TOTAL INITIAL WATER                =     65.272  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         BALTIMORE             MARYLAND

    STATION LATITUDE                        =  39.18 DEGREES
    MAXIMUM LEAF AREA INDEX                 =   0.00
    START OF GROWING SEASON (JULIAN DATE)   =    102
    END OF GROWING SEASON (JULIAN DATE)     =    300
    EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
    AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
```

```
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        3.47        3.02        3.93        3.00        3.89        3.43
        3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       32.40       35.50       43.70       53.20       62.80       71.70
       76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                 MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.001   0.000   0.000   0.000   0.000   0.017
                                  0.000   0.083   2.478   0.070   0.003   0.497

EVAPOTRANSPIRATION                1.826   1.852   2.705   2.062   1.728   4.375
                                  1.390   3.389   0.869   3.032   2.314   1.288

LATERAL DRAINAGE COLLECTED        4.6126  1.5438  0.9825  0.5220  0.4809  0.3798
```

```
  FROM LAYER  9                   0.2846  0.4570  0.2326  0.5734  3.0209  1.2533

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.001   0.001   0.000   0.000   0.000   0.000
  TOP OF LAYER 10                 0.000   0.000   0.000   0.000   0.001   0.000

STD. DEVIATION OF DAILY           0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER 10         0.000   0.000   0.000   0.000   0.000   0.000

*******************************************************************************



*******************************************************************************

                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                           44.01          159756.297    100.00

  RUNOFF                                   3.148          11428.088      7.15

  EVAPOTRANSPIRATION                      26.832          97400.617     60.97

  DRAINAGE COLLECTED FROM LAYER  9        14.3435         52066.855     32.59

  PERC./LEAKAGE THROUGH LAYER 10           0.000002           0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10             0.0004

  CHANGE IN WATER STORAGE                 -0.314          -1139.277     -0.71

  SOIL WATER AT START OF YEAR             65.274         236945.047

  SOIL WATER AT END OF YEAR               64.960         235805.766

  SNOW WATER AT START OF YEAR              0.000              0.000      0.00

  SNOW WATER AT END OF YEAR                0.000              0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000            -0.003      0.00

*******************************************************************************
```

```
*******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.001    0.000    0.000    0.000    0.000    0.017
                           0.000    0.083    2.478    0.070    0.003    0.497

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.826    1.852    2.705    2.062    1.728    4.375
                           1.390    3.389    0.869    3.032    2.314    1.288

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.6126   1.5438   0.9825   0.5220   0.4809   0.3798
                           0.2846   0.4570   0.2326   0.5734   3.0209   1.2533

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0015   0.0006   0.0003   0.0002   0.0002   0.0001
                           0.0001   0.0001   0.0001   0.0002   0.0010   0.0004
```

```
    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                      INCHES           CU. FEET      PERCENT
                                -------------------  -------------  ---------
 PRECIPITATION                   44.01    (   0.000)    159756.3     100.00

 RUNOFF                           3.148   (  0.0000)     11428.09      7.153

 EVAPOTRANSPIRATION              26.832   (  0.0000)     97400.62     60.968

 LATERAL DRAINAGE COLLECTED      14.34349 (  0.00000)    52066.855   32.59143
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009    0.00001
   LAYER 10

 AVERAGE HEAD ON TOP              0.000 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE         -0.314   (  0.0000)     -1139.28     -0.713

*******************************************************************************
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******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                           (INCHES)      (CU. FT.)
                                          ----------   -------------
    PRECIPITATION                            6.16         22360.799

    RUNOFF                                   2.478         8995.4043

    DRAINAGE COLLECTED FROM LAYER  9         0.26918        977.11505

    PERCOLATION/LEAKAGE THROUGH LAYER 10     0.000000          0.00002

    AVERAGE HEAD ON TOP OF LAYER 10          0.003

    MAXIMUM HEAD ON TOP OF LAYER 10          0.027

    LOCATION OF MAXIMUM HEAD IN LAYER  9
          (DISTANCE FROM DRAIN)              0.0 FEET

    SNOW WATER                               0.77          2798.9209


    MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.3698

    MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


     ***  Maximum heads are computed using McEnroe's equations.  ***

          Reference:  Maximum Saturated Depth over Landfill Liner
                      by Bruce M. McEnroe, University of Kansas
                      ASCE Journal of Environmental Engineering
                      Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1            2.6619         0.2218

                    2           18.6546         0.0777

                    3            3.4569         0.2881

                    4           11.2443         0.0781

                    5            3.6521         0.3043

                    6            7.5693         0.0788

                    7           12.2927         0.2561

                    8            5.4249         0.2260

                    9            0.0018         0.0117

                   10            0.0000         0.0000

                SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – EIGHT (8) LIFTS

Floor slope 2%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**               USAE WATERWAYS EXPERIMENT STATION                          **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF8S2.OUT


TIME:  14:41     DATE:   6/24/2020


******************************************************************************

     TITLE:  FULL FILL @8 LIFTS; S = 2%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    384.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2131 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    288.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0766 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2928 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0765 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2958 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2298 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1168 VOL/VOL
```

```
      EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
      SLOPE                       =      2.00   PERCENT
      DRAINAGE LENGTH             =    250.0    FEET


                        LAYER 10
                        --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
      THICKNESS                   =      0.06   INCHES
      POROSITY                    =      0.0000 VOL/VOL
      FIELD CAPACITY              =      0.0000 VOL/VOL
      WILTING POINT               =      0.0000 VOL/VOL
      INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
      FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
      FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
      FML PLACEMENT QUALITY       =  1 - PERFECT



              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

   SCS RUNOFF CURVE NUMBER            =     86.00
   FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
   INITIAL SNOW WATER                 =      0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =     86.791  INCHES
   TOTAL INITIAL WATER                =     86.791  INCHES
   TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BALTIMORE             MARYLAND

        STATION LATITUDE                        =  39.18 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    102
        END OF GROWING SEASON (JULIAN DATE)     =    300
        EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
```

```
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  3.47        3.02        3.93        3.00        3.89        3.43
  3.85        3.74        3.98        3.16        3.12        3.35


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
 32.40       35.50       43.70       53.20       62.80       71.70
 76.50       74.50       67.40       55.30       45.50       36.60


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BALTIMORE           MARYLAND
               AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                               JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                               ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.015
                                 0.000   0.060   2.600   0.069   0.001   0.332

EVAPOTRANSPIRATION               1.811   1.893   2.700   2.247   1.953   4.919
                                 1.729   3.442   1.131   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED       4.8495  1.7506  0.9811  0.5152  0.6024  0.3927
```

```
  FROM LAYER  9                 0.3104  0.2751  0.3222  0.2586  1.6998  1.2295

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.078   0.031   0.016   0.009   0.010   0.007
  TOP OF LAYER 10               0.005   0.004   0.005   0.004   0.028   0.020

STD. DEVIATION OF DAILY         0.035   0.009   0.004   0.001   0.001   0.001
  HEAD ON TOP OF LAYER 10       0.000   0.001   0.002   0.002   0.020   0.006

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                           44.01          159756.297    100.00

  RUNOFF                                   3.077          11168.417      6.99

  EVAPOTRANSPIRATION                      28.424         103179.672     64.59

  DRAINAGE COLLECTED FROM LAYER  9        13.1871         47869.066     29.96

  PERC./LEAKAGE THROUGH LAYER 10           0.000003           0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10             0.0181

  CHANGE IN WATER STORAGE                 -0.678          -2460.813     -1.54

  SOIL WATER AT START OF YEAR             86.808         315113.687

  SOIL WATER AT END OF YEAR               86.130         312652.875

  SNOW WATER AT START OF YEAR              0.000              0.000      0.00

  SNOW WATER AT END OF YEAR                0.000              0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000            -0.060      0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.015
                           0.000    0.060    2.600    0.069    0.001    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.811    1.893    2.700    2.247    1.953    4.919
                           1.729    3.442    1.131    3.011    2.305    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8495   1.7506   0.9811   0.5152   0.6024   0.3927
                           0.3104   0.2751   0.3222   0.2586   1.6998   1.2295

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  ------------------------------------
    AVERAGES               0.0781   0.0312   0.0158   0.0086   0.0097   0.0065
                           0.0050   0.0044   0.0054   0.0042   0.0283   0.0198
```

```
   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES           CU. FEET      PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          3.077   (  0.0000)      11168.42      6.991

 EVAPOTRANSPIRATION             28.424   (  0.0000)     103179.67     64.586

 LATERAL DRAINAGE COLLECTED     13.18707 (  0.00000)     47869.066   29.96381
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP             0.018 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE        -0.678   (  0.0000)      -2460.81     -1.540

*******************************************************************************
```

```
*******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
   PRECIPITATION                                  6.16          22360.799

   RUNOFF                                         2.600          9439.0186

   DRAINAGE COLLECTED FROM LAYER  9               0.26524         962.80597

   PERCOLATION/LEAKAGE THROUGH LAYER 10           0.000000          0.00005

   AVERAGE HEAD ON TOP OF LAYER 10                0.132

   MAXIMUM HEAD ON TOP OF LAYER 10                0.259

   LOCATION OF MAXIMUM HEAD IN LAYER  9
         (DISTANCE FROM DRAIN)                    4.9 FEET

   SNOW WATER                                     0.77           2798.9209


   MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.4530

   MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.0850

    ***  Maximum heads are computed using McEnroe's equations.  ***

         Reference:  Maximum Saturated Depth over Landfill Liner
                     by Bruce M. McEnroe, University of Kansas
                     ASCE Journal of Environmental Engineering
                     Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
******************************************************************************

                 FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                  LAYER        (INCHES)       (VOL/VOL)
                  -----        --------       ---------
                    1            2.5515         0.2126

                    2           29.4314         0.0766

                    3            3.5007         0.2917

                    4           22.3261         0.0775

                    5            3.5000         0.2917

                    6            7.3269         0.0763

                    7           12.0617         0.2513

                    8            5.4004         0.2250

                    9            0.0140         0.0934

                   10            0.0000         0.0000

                 SNOW WATER      0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – EIGHT (8) LIFTS

Floor slope 3%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF8S3.OUT


TIME:  14:46     DATE:   6/24/2020


******************************************************************************

     TITLE:  FULL FILL @8 LIFTS; S =3%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =   384.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2131 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =   288.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0766 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                                   LAYER  5
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2928 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                       LAYER  6
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
     THICKNESS                  =     96.00   INCHES
     POROSITY                   =      0.1680 VOL/VOL
     FIELD CAPACITY             =      0.0730 VOL/VOL
     WILTING POINT              =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0765 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                       LAYER  7
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
     THICKNESS                  =     48.00   INCHES
     POROSITY                   =      0.4530 VOL/VOL
     FIELD CAPACITY             =      0.1900 VOL/VOL
     WILTING POINT              =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2958 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC



                       LAYER  8
                       --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
     THICKNESS                  =     24.00   INCHES
     POROSITY                   =      0.4570 VOL/VOL
     FIELD CAPACITY             =      0.1310 VOL/VOL
     WILTING POINT              =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.2298 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC



                       LAYER  9
                       --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                  =      0.15   INCHES
     POROSITY                   =      0.8500 VOL/VOL
     FIELD CAPACITY             =      0.0100 VOL/VOL
     WILTING POINT              =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0884 VOL/VOL
```

```
     EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
     SLOPE                      =      3.00   PERCENT
     DRAINAGE LENGTH            =    250.0    FEET



                       LAYER 10
                       --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
     THICKNESS                  =      0.06   INCHES
     POROSITY                   =      0.0000 VOL/VOL
     FIELD CAPACITY             =      0.0000 VOL/VOL
     WILTING POINT              =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
     FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
     FML PLACEMENT QUALITY      =  1 - PERFECT




             GENERAL DESIGN AND EVAPORATIVE ZONE DATA
             ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

 SCS RUNOFF CURVE NUMBER            =     86.00
 FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
 INITIAL SNOW WATER                 =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =     86.786  INCHES
 TOTAL INITIAL WATER                =     86.786  INCHES
 TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


              EVAPOTRANSPIRATION AND WEATHER DATA
              -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           BALTIMORE             MARYLAND

      STATION LATITUDE                        =  39.18 DEGREES
      MAXIMUM LEAF AREA INDEX                 =   0.00
      START OF GROWING SEASON (JULIAN DATE)   =    102
      END OF GROWING SEASON (JULIAN DATE)     =    300
      EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
      AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
```

```
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.015
                                 0.000   0.060   2.600   0.069   0.001   0.332

EVAPOTRANSPIRATION               1.811   1.893   2.700   2.247   1.953   4.919
                                 1.729   3.442   1.131   3.011   2.305   1.282

LATERAL DRAINAGE COLLECTED       4.8600  1.7422  0.9780  0.5140  0.6027  0.3917
```

```
  FROM LAYER  9                  0.3101  0.2752  0.3217  0.2587  1.7073  1.2253

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.052   0.021   0.011   0.006   0.006   0.004
  TOP OF LAYER 10                0.003   0.003   0.004   0.003   0.019   0.013

STD. DEVIATION OF DAILY          0.024   0.006   0.003   0.001   0.001   0.001
  HEAD ON TOP OF LAYER 10        0.000   0.000   0.001   0.001   0.013   0.004

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           44.01         159756.297    100.00

  RUNOFF                                   3.077         11168.417      6.99

  EVAPOTRANSPIRATION                      28.424        103179.672     64.59

  DRAINAGE COLLECTED FROM LAYER  9        13.1870        47868.914     29.96

  PERC./LEAKAGE THROUGH LAYER 10           0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10             0.0121

  CHANGE IN WATER STORAGE                 -0.678         -2460.646     -1.54

  SOIL WATER AT START OF YEAR             86.800        315082.781

  SOIL WATER AT END OF YEAR               86.122        312622.156

  SNOW WATER AT START OF YEAR              0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.073      0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.015
                           0.000    0.060    2.600    0.069    0.001    0.332

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.811    1.893    2.700    2.247    1.953    4.919
                           1.729    3.442    1.131    3.011    2.305    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8600   1.7422   0.9780   0.5140   0.6027   0.3917
                           0.3101   0.2752   0.3217   0.2587   1.7073   1.2253

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0522   0.0207   0.0105   0.0057   0.0065   0.0043
                           0.0033   0.0030   0.0036   0.0028   0.0189   0.0132
```

```
    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                                   INCHES             CU. FEET      PERCENT
                             -------------------   -------------   ---------
 PRECIPITATION                44.01    (   0.000)     159756.3     100.00

 RUNOFF                        3.077   (  0.0000)      11168.42      6.991

 EVAPOTRANSPIRATION           28.424   (  0.0000)     103179.67     64.586

 LATERAL DRAINAGE COLLECTED   13.18703 (  0.00000)     47868.914   29.96371
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH   0.00000 (  0.00000)         0.009    0.00001
   LAYER 10

 AVERAGE HEAD ON TOP           0.012 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE      -0.678   (  0.0000)      -2460.65     -1.540

*******************************************************************************
```

```
******************************************************************************

              PEAK DAILY VALUES FOR YEARS     1 THROUGH    1
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
      PRECIPITATION                            6.16        22360.799

      RUNOFF                                   2.600        9439.0186

      DRAINAGE COLLECTED FROM LAYER  9         0.26942       978.00031

      PERCOLATION/LEAKAGE THROUGH LAYER 10     0.000000         0.00004

      AVERAGE HEAD ON TOP OF LAYER 10          0.090

      MAXIMUM HEAD ON TOP OF LAYER 10          0.177

      LOCATION OF MAXIMUM HEAD IN LAYER  9
            (DISTANCE FROM DRAIN)              2.7 FEET

      SNOW WATER                               0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.5515         0.2126

                  2           29.4314         0.0766

                  3            3.5007         0.2917

                  4           22.3261         0.0775

                  5            3.5000         0.2917

                  6            7.3269         0.0763

                  7           12.0617         0.2513

                  8            5.4004         0.2250

                  9            0.0098         0.0653

                 10            0.0000         0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – EIGHT (8) LIFTS

Floor slope 4%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\DATA4.D4
TEMPERATURE DATA FILE:       C:\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\DATA10.D10
OUTPUT DATA FILE:            C:\FF8S4.OUT


TIME:  14:50     DATE:   6/24/2020


******************************************************************************

     TITLE:  FULL FILL @8 LIFTS; S = 4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                  =     12.00   INCHES
           POROSITY                   =      0.4530 VOL/VOL
           FIELD CAPACITY             =      0.1900 VOL/VOL
           WILTING POINT              =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
     THICKNESS                   =    384.00   INCHES
     POROSITY                    =      0.1680 VOL/VOL
     FIELD CAPACITY              =      0.0730 VOL/VOL
     WILTING POINT               =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   6
     THICKNESS                   =     12.00   INCHES
     POROSITY                    =      0.4530 VOL/VOL
     FIELD CAPACITY              =      0.1900 VOL/VOL
     WILTING POINT               =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2171 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
     THICKNESS                   =    288.00   INCHES
     POROSITY                    =      0.1680 VOL/VOL
     FIELD CAPACITY              =      0.0730 VOL/VOL
     WILTING POINT               =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0761 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   6
     THICKNESS                   =     12.00   INCHES
     POROSITY                    =      0.4530 VOL/VOL
     FIELD CAPACITY              =      0.1900 VOL/VOL
     WILTING POINT               =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2919 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
     THICKNESS                   =     96.00   INCHES
     POROSITY                    =      0.1680 VOL/VOL
     FIELD CAPACITY              =      0.0730 VOL/VOL
     WILTING POINT               =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0784 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   6
     THICKNESS                   =     48.00   INCHES
     POROSITY                    =      0.4530 VOL/VOL
     FIELD CAPACITY              =      0.1900 VOL/VOL
     WILTING POINT               =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2954 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   5
     THICKNESS                   =     24.00   INCHES
     POROSITY                    =      0.4570 VOL/VOL
     FIELD CAPACITY              =      0.1310 VOL/VOL
     WILTING POINT               =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2282 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                   MATERIAL TEXTURE NUMBER   0
     THICKNESS                   =      0.15   INCHES
     POROSITY                    =      0.8500 VOL/VOL
     FIELD CAPACITY              =      0.0100 VOL/VOL
     WILTING POINT               =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.0623 VOL/VOL
```

```
  EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
  SLOPE                       =      4.00   PERCENT
  DRAINAGE LENGTH             =    250.0    FEET


                          LAYER 10
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
  THICKNESS                   =      0.06   INCHES
  POROSITY                    =      0.0000 VOL/VOL
  FIELD CAPACITY              =      0.0000 VOL/VOL
  WILTING POINT               =      0.0000 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
  FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
  FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
  FML PLACEMENT QUALITY       =  1 - PERFECT



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

 SCS RUNOFF CURVE NUMBER            =     86.00
 FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
 INITIAL SNOW WATER                 =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =     86.801  INCHES
 TOTAL INITIAL WATER                =     86.801  INCHES
 TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

     STATION LATITUDE                       =  39.18 DEGREES
     MAXIMUM LEAF AREA INDEX                =   0.00
     START OF GROWING SEASON (JULIAN DATE)  =    102
     END OF GROWING SEASON (JULIAN DATE)    =    300
     EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
     AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
```

```
           AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


       NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND

                NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


       NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND

           NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60


       NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                COEFFICIENTS FOR    BALTIMORE           MARYLAND
                  AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.016
                                  0.000   0.064   2.589   0.068   0.001   0.353

EVAPOTRANSPIRATION                1.805   1.880   2.771   2.254   1.951   4.909
                                  1.762   3.476   1.136   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED        4.8580  1.7445  0.9847  0.5154  0.5976  0.3960
```

```
  FROM LAYER  9                 0.3146  0.2973  0.2905  0.2497  1.5381  1.2753

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.039   0.016   0.008   0.004   0.005   0.003
  TOP OF LAYER 10               0.003   0.002   0.002   0.002   0.013   0.010

STD. DEVIATION OF DAILY         0.018   0.004   0.002   0.001   0.000   0.000
  HEAD ON TOP OF LAYER 10       0.000   0.000   0.000   0.001   0.010   0.003

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                           44.01         159756.297    100.00

  RUNOFF                                   3.091         11220.854      7.02

  EVAPOTRANSPIRATION                      28.542        103606.211     64.85

  DRAINAGE COLLECTED FROM LAYER  9        13.0616        47413.543     29.68

  PERC./LEAKAGE THROUGH LAYER 10           0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10             0.0090

  CHANGE IN WATER STORAGE                 -0.684         -2484.353     -1.56

  SOIL WATER AT START OF YEAR             86.810        315119.781

  SOIL WATER AT END OF YEAR               86.125        312635.437

  SNOW WATER AT START OF YEAR              0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE              0.0000            0.029      0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.016
                           0.000    0.064    2.589    0.068    0.001    0.353

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.880    2.771    2.254    1.951    4.909
                           1.762    3.476    1.136    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8580   1.7445   0.9847   0.5154   0.5976   0.3960
                           0.3146   0.2973   0.2905   0.2497   1.5381   1.2753

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0391   0.0156   0.0079   0.0043   0.0048   0.0033
                           0.0025   0.0024   0.0024   0.0020   0.0128   0.0103
```

```
   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET     PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          3.091   (  0.0000)      11220.85      7.024

 EVAPOTRANSPIRATION             28.542   (  0.0000)     103606.21     64.853

 LATERAL DRAINAGE COLLECTED     13.06158 (  0.00000)     47413.543   29.67867
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP             0.009 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE        -0.684   (  0.0000)      -2484.35     -1.555

*******************************************************************************
```

```
*******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------    -------------
   PRECIPITATION                                  6.16          22360.799

   RUNOFF                                         2.589          9398.5059

   DRAINAGE COLLECTED FROM LAYER  9               0.26875         975.55267

   PERCOLATION/LEAKAGE THROUGH LAYER 10           0.000000          0.00003

   AVERAGE HEAD ON TOP OF LAYER 10                0.067

   MAXIMUM HEAD ON TOP OF LAYER 10                0.134

   LOCATION OF MAXIMUM HEAD IN LAYER  9
         (DISTANCE FROM DRAIN)                    1.0 FEET

   SNOW WATER                                     0.77           2798.9209


   MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.4530

   MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.0850

    ***  Maximum heads are computed using McEnroe's equations.  ***

         Reference:  Maximum Saturated Depth over Landfill Liner
                     by Bruce M. McEnroe, University of Kansas
                     ASCE Journal of Environmental Engineering
                     Vol. 119, No. 2, March 1993, pp. 262-270.


*******************************************************************************
```

```
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
               LAYER         (INCHES)        (VOL/VOL)
               -----         --------        ---------
                 1             2.6121          0.2177

                 2            29.2900          0.0763

                 3             3.4721          0.2893

                 4            22.5424          0.0783

                 5             3.5467          0.2956

                 6             7.2014          0.0750

                 7            12.0332          0.2507

                 8             5.4118          0.2255

                 9             0.0064          0.0427

                10             0.0000          0.0000

              SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – EIGHT (8) LIFTS

Floor slope 5%

```
*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************




PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF8S5.OUT



TIME:  14:53     DATE:   6/24/2020




*******************************************************************************

     TITLE:  FULL FILL @8 LIFTS; S = 5%

*******************************************************************************




     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =     0.4530 VOL/VOL
           FIELD CAPACITY              =     0.1900 VOL/VOL
           WILTING POINT               =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =   384.00   INCHES
           POROSITY                    =     0.1680 VOL/VOL
           FIELD CAPACITY              =     0.0730 VOL/VOL
           WILTING POINT               =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.0755 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =     0.4530 VOL/VOL
           FIELD CAPACITY              =     0.1900 VOL/VOL
           WILTING POINT               =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.2171 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC



                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =   288.00   INCHES
           POROSITY                    =     0.1680 VOL/VOL
           FIELD CAPACITY              =     0.0730 VOL/VOL
           WILTING POINT               =     0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.0761 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                                   LAYER  5
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =     0.4530 VOL/VOL
           FIELD CAPACITY              =     0.1900 VOL/VOL
           WILTING POINT               =     0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.2919 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  19
    THICKNESS                  =     96.00   INCHES
    POROSITY                   =      0.1680 VOL/VOL
    FIELD CAPACITY             =      0.0730 VOL/VOL
    WILTING POINT              =      0.0190 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0784 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   6
    THICKNESS                  =     48.00   INCHES
    POROSITY                   =      0.4530 VOL/VOL
    FIELD CAPACITY             =      0.1900 VOL/VOL
    WILTING POINT              =      0.0850 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2954 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   5
    THICKNESS                  =     24.00   INCHES
    POROSITY                   =      0.4570 VOL/VOL
    FIELD CAPACITY             =      0.1310 VOL/VOL
    WILTING POINT              =      0.0580 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2282 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

               TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER   0
    THICKNESS                  =      0.15   INCHES
    POROSITY                   =      0.8500 VOL/VOL
    FIELD CAPACITY             =      0.0100 VOL/VOL
    WILTING POINT              =      0.0050 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0516 VOL/VOL
```

```
    EFFECTIVE SAT. HYD. COND.  =   4.42000008000     CM/SEC
    SLOPE                      =      5.00   PERCENT
    DRAINAGE LENGTH            =    250.0    FEET


                        LAYER 10
                        --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
    THICKNESS                  =      0.06   INCHES
    POROSITY                   =      0.0000 VOL/VOL
    FIELD CAPACITY             =      0.0000 VOL/VOL
    WILTING POINT              =      0.0000 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
    FML PINHOLE DENSITY        =      0.00   HOLES/ACRE
    FML INSTALLATION DEFECTS   =      0.00   HOLES/ACRE
    FML PLACEMENT QUALITY      =  1 - PERFECT


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

 SCS RUNOFF CURVE NUMBER            =     86.00
 FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
 INITIAL SNOW WATER                 =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =     86.799  INCHES
 TOTAL INITIAL WATER                =     86.799  INCHES
 TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           BALTIMORE             MARYLAND

      STATION LATITUDE                      =  39.18 DEGREES
      MAXIMUM LEAF AREA INDEX               =   0.00
      START OF GROWING SEASON (JULIAN DATE) =    102
      END OF GROWING SEASON (JULIAN DATE)   =    300
      EVAPORATIVE ZONE DEPTH                =   9.0  INCHES
      AVERAGE ANNUAL WIND SPEED             =   9.30 MPH
```

```
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


      NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

               NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
      3.47        3.02        3.93        3.00        3.89        3.43
      3.85        3.74        3.98        3.16        3.12        3.35


      NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     32.40       35.50       43.70       53.20       62.80       71.70
     76.50       74.50       67.40       55.30       45.50       36.60


      NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    BALTIMORE           MARYLAND
                 AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                     2.00    1.42    3.53    1.61    2.69    4.35
                                  2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                            0.000   0.000   0.000   0.000   0.000   0.016
                                  0.000   0.064   2.589   0.068   0.001   0.353

EVAPOTRANSPIRATION                1.805   1.880   2.771   2.254   1.951   4.909
                                  1.762   3.476   1.136   3.011   2.304   1.282

LATERAL DRAINAGE COLLECTED        4.8608  1.7420  0.9836  0.5154  0.5976  0.3957
```

```
  FROM LAYER  9                   0.3145  0.2974  0.2904  0.2496  1.5404  1.2737

PERCOLATION/LEAKAGE THROUGH       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                        0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON             0.031   0.012   0.006   0.003   0.004   0.003
  TOP OF LAYER 10                 0.002   0.002   0.002   0.002   0.010   0.008

STD. DEVIATION OF DAILY           0.015   0.004   0.002   0.001   0.000   0.000
  HEAD ON TOP OF LAYER 10         0.000   0.000   0.000   0.001   0.008   0.002

*******************************************************************************


*******************************************************************************

                         ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                       INCHES          CU. FEET      PERCENT
                                      --------        ----------     -------
  PRECIPITATION                         44.01         159756.297     100.00

  RUNOFF                                 3.091         11220.854       7.02

  EVAPOTRANSPIRATION                    28.542        103606.211      64.85

  DRAINAGE COLLECTED FROM LAYER  9      13.0609        47411.168      29.68

  PERC./LEAKAGE THROUGH LAYER 10         0.000002          0.009       0.00

  AVG. HEAD ON TOP OF LAYER 10           0.0072

  CHANGE IN WATER STORAGE               -0.684         -2481.999      -1.55

  SOIL WATER AT START OF YEAR           86.807        315108.094

  SOIL WATER AT END OF YEAR             86.123        312626.094

  SNOW WATER AT START OF YEAR            0.000             0.000       0.00

  SNOW WATER AT END OF YEAR              0.000             0.000       0.00

  ANNUAL WATER BUDGET BALANCE            0.0000            0.047       0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.016
                           0.000    0.064    2.589    0.068    0.001    0.353

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.805    1.880    2.771    2.254    1.951    4.909
                           1.762    3.476    1.136    3.011    2.304    1.282

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.8608   1.7420   0.9836   0.5154   0.5976   0.3957
                           0.3145   0.2974   0.2904   0.2496   1.5404   1.2737

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0314   0.0124   0.0063   0.0034   0.0039   0.0026
                           0.0020   0.0019   0.0019   0.0016   0.0103   0.0082
```

```
    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               --------------------- -------------   ---------
 PRECIPITATION                  44.01    (   0.000)     159756.3     100.00

 RUNOFF                          3.091   (  0.0000)      11220.85      7.024

 EVAPOTRANSPIRATION             28.542   (  0.0000)     103606.21     64.853

 LATERAL DRAINAGE COLLECTED     13.06093 (  0.00000)     47411.168   29.67719
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.009     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP             0.007 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE        -0.684   (  0.0000)      -2482.00     -1.554

*******************************************************************************
```

```
******************************************************************************

             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
   ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                           6.16        22360.799

      RUNOFF                                  2.589        9398.5059

      DRAINAGE COLLECTED FROM LAYER  9        0.26987       979.63843

      PERCOLATION/LEAKAGE THROUGH LAYER 10    0.000000        0.00003

      AVERAGE HEAD ON TOP OF LAYER 10         0.054

      MAXIMUM HEAD ON TOP OF LAYER 10         0.108

      LOCATION OF MAXIMUM HEAD IN LAYER  9
            (DISTANCE FROM DRAIN)             0.0 FEET

      SNOW WATER                              0.77         2798.9209


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4530

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.0850


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************
```

```
******************************************************************************

              FINAL WATER STORAGE AT END OF YEAR    1
   ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1            2.6121         0.2177

                 2           29.2900         0.0763

                 3            3.4721         0.2893

                 4           22.5424         0.0783

                 5            3.5467         0.2956

                 6            7.2014         0.0750

                 7           12.0332         0.2507

                 8            5.4118         0.2255

                 9            0.0054         0.0363

                10            0.0000         0.0000

             SNOW WATER       0.000

******************************************************************************
******************************************************************************
```

ADVANCED GeoServices
a Montrose Environmental Group company

HELP MODEL PRINTOUTS

FULL -HEIGHT – EIGHT (8) LIFTS

Floor slope 6%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                     USAE WATERWAYS EXPERIMENT STATION                    **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF8S6.OUT


TIME:  15: 3     DATE:   6/24/2020


******************************************************************************

     TITLE:  FULL FILL @8 LIFTS; S = 6%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                     =     12.00   INCHES
           POROSITY                      =      0.4530 VOL/VOL
           FIELD CAPACITY                =      0.1900 VOL/VOL
           WILTING POINT                 =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    384.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2187 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    288.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0774 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2911 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =     96.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0757 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   6
THICKNESS                   =     48.00   INCHES
POROSITY                    =      0.4530 VOL/VOL
FIELD CAPACITY              =      0.1900 VOL/VOL
WILTING POINT               =      0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2962 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2226 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.15   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0528 VOL/VOL
```

```
   EFFECTIVE SAT. HYD. COND.   =   4.42000008000     CM/SEC
   SLOPE                       =      6.00   PERCENT
   DRAINAGE LENGTH             =    250.0    FEET


                           LAYER 10
                           --------

               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  1 - PERFECT



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER             =     86.00
FRACTION OF AREA ALLOWING RUNOFF    =     75.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      9.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      1.944  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      4.077  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.765  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     86.828  INCHES
TOTAL INITIAL WATER                 =     86.828  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

     STATION LATITUDE                       =  39.18 DEGREES
     MAXIMUM LEAF AREA INDEX                =   0.00
     START OF GROWING SEASON (JULIAN DATE)  =    102
     END OF GROWING SEASON (JULIAN DATE)    =    300
     EVAPORATIVE ZONE DEPTH                 =   9.0  INCHES
     AVERAGE ANNUAL WIND SPEED              =   9.30 MPH
```

```
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       3.47        3.02        3.93        3.00        3.89        3.43
       3.85        3.74        3.98        3.16        3.12        3.35


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      32.40       35.50       43.70       53.20       62.80       71.70
      76.50       74.50       67.40       55.30       45.50       36.60


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BALTIMORE           MARYLAND
                    AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                  MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.001   0.000   0.000   0.000   0.000   0.016
                                 0.000   0.070   2.562   0.069   0.001   0.385

EVAPOTRANSPIRATION               1.804   1.891   2.770   2.244   1.962   4.893
                                 1.762   3.479   1.128   3.025   2.302   1.281

LATERAL DRAINAGE COLLECTED       4.7205  1.8848  1.0002  0.5204  0.5976  0.3971
```

```
  FROM LAYER  9                 0.3143  0.2868  0.2983  0.2483  1.5358  1.2828

PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON           0.025   0.011   0.005   0.003   0.003   0.002
  TOP OF LAYER 10               0.002   0.002   0.002   0.001   0.009   0.007

STD. DEVIATION OF DAILY         0.013   0.004   0.001   0.001   0.000   0.000
  HEAD ON TOP OF LAYER 10       0.000   0.000   0.000   0.001   0.007   0.002

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                          44.01         159756.297    100.00

  RUNOFF                                  3.103         11263.241      7.05

  EVAPOTRANSPIRATION                     28.542        103605.773     64.85

  DRAINAGE COLLECTED FROM LAYER  9       13.0870        47505.680     29.74

  PERC./LEAKAGE THROUGH LAYER 10          0.000002          0.009      0.00

  AVG. HEAD ON TOP OF LAYER 10            0.0060

  CHANGE IN WATER STORAGE                -0.721         -2618.451     -1.64

  SOIL WATER AT START OF YEAR            86.836        315213.969

  SOIL WATER AT END OF YEAR              86.114        312595.500

  SNOW WATER AT START OF YEAR             0.000             0.000      0.00

  SNOW WATER AT END OF YEAR               0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE             0.0000            0.036      0.00

*******************************************************************************
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 2.00     1.42     3.53     1.61     2.69     4.35
                           2.02     3.97     7.14     4.15     3.78     7.35

    STD. DEVIATIONS        0.00     0.00     0.00     0.00     0.00     0.00
                           0.00     0.00     0.00     0.00     0.00     0.00

  RUNOFF
  ------
    TOTALS                 0.001    0.000    0.000    0.000    0.000    0.016
                           0.000    0.070    2.562    0.069    0.001    0.385

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 1.804    1.891    2.770    2.244    1.962    4.893
                           1.762    3.479    1.128    3.025    2.302    1.281

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  LATERAL DRAINAGE COLLECTED FROM LAYER  9
  ----------------------------------------
    TOTALS                 4.7205   1.8848   1.0002   0.5204   0.5976   0.3971
                           0.3143   0.2868   0.2983   0.2483   1.5358   1.2828

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER 10
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER 10
  -------------------------------------
    AVERAGES               0.0254   0.0112   0.0054   0.0029   0.0032   0.0022
                           0.0017   0.0015   0.0017   0.0013   0.0085   0.0069
```

```
   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                   INCHES            CU. FEET     PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                 44.01    (   0.000)     159756.3     100.00

 RUNOFF                         3.103   (  0.0000)      11263.24      7.050

 EVAPOTRANSPIRATION            28.542   (  0.0000)     103605.77     64.852

 LATERAL DRAINAGE COLLECTED    13.08696 (  0.00000)     47505.680   29.73634
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH    0.00000 (  0.00000)         0.009     0.00001
   LAYER 10

 AVERAGE HEAD ON TOP            0.006 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE       -0.721   (  0.0000)      -2618.45     -1.639

*******************************************************************************
```

```
*******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------   -------------
   PRECIPITATION                                  6.16          22360.799

   RUNOFF                                         2.562          9301.0596

   DRAINAGE COLLECTED FROM LAYER  9               0.26002         943.87512

   PERCOLATION/LEAKAGE THROUGH LAYER 10           0.000000          0.00002

   AVERAGE HEAD ON TOP OF LAYER 10                0.043

   MAXIMUM HEAD ON TOP OF LAYER 10                0.088

   LOCATION OF MAXIMUM HEAD IN LAYER  9
         (DISTANCE FROM DRAIN)                    0.0 FEET

   SNOW WATER                                     0.77           2798.9209


   MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.4501

   MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.0850

    ***  Maximum heads are computed using McEnroe's equations.  ***

         Reference:  Maximum Saturated Depth over Landfill Liner
                     by Bruce M. McEnroe, University of Kansas
                     ASCE Journal of Environmental Engineering
                     Vol. 119, No. 2, March 1993, pp. 262-270.

*******************************************************************************
```

```
*******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR    1
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.6247         0.2187

                      2           29.6053         0.0771

                      3            3.4608         0.2884

                      4           22.3189         0.0775

                      5            3.5583         0.2965

                      6            7.1260         0.0742

                      7           12.0090         0.2502

                      8            5.3961         0.2248

                      9            0.0074         0.0496

                     10            0.0000         0.0000

                  SNOW WATER       0.000

*******************************************************************************
*******************************************************************************
```

HELP MODEL PRINTOUTS

FULL -HEIGHT – EIGHT (8) LIFTS

Floor slope 33%

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\DATA4.D4
TEMPERATURE DATA FILE:      C:\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\DATA10.D10
OUTPUT DATA FILE:           C:\FF8S33.OUT


TIME:  12:17     DATE:   6/26/2020


******************************************************************************

     TITLE:  FULL FILL @8 LIFTS, S = 33%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2160 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =    384.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0755 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                                   LAYER  3
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2884 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC


                                   LAYER  4
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  19
           THICKNESS                   =    288.00   INCHES
           POROSITY                    =      0.1680 VOL/VOL
           FIELD CAPACITY              =      0.0730 VOL/VOL
           WILTING POINT               =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0775 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                                   LAYER  5
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4530 VOL/VOL
           FIELD CAPACITY              =      0.1900 VOL/VOL
           WILTING POINT               =      0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2965 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.720000011000E-03 CM/SEC
```

```
                        LAYER  6
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
     THICKNESS                    =     96.00   INCHES
     POROSITY                     =      0.1680 VOL/VOL
     FIELD CAPACITY               =      0.0730 VOL/VOL
     WILTING POINT                =      0.0190 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0742 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   6
     THICKNESS                    =     48.00   INCHES
     POROSITY                     =      0.4530 VOL/VOL
     FIELD CAPACITY               =      0.1900 VOL/VOL
     WILTING POINT                =      0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.2502 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC


                        LAYER  8
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
     THICKNESS                    =     24.00   INCHES
     POROSITY                     =      0.4570 VOL/VOL
     FIELD CAPACITY               =      0.1310 VOL/VOL
     WILTING POINT                =      0.0580 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.2248 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                        LAYER  9
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                    =      0.15   INCHES
     POROSITY                     =      0.8500 VOL/VOL
     FIELD CAPACITY               =      0.0100 VOL/VOL
     WILTING POINT                =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0496 VOL/VOL
```

```
     EFFECTIVE SAT. HYD. COND.    =   4.42000008000     CM/SEC
     SLOPE                        =     33.00   PERCENT
     DRAINAGE LENGTH              =     75.0    FEET


                        LAYER 10
                        --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
     THICKNESS                    =      0.06   INCHES
     POROSITY                     =      0.0000 VOL/VOL
     FIELD CAPACITY               =      0.0000 VOL/VOL
     WILTING POINT                =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
     FML PINHOLE DENSITY          =      0.00   HOLES/ACRE
     FML INSTALLATION DEFECTS     =      0.00   HOLES/ACRE
     FML PLACEMENT QUALITY        =  1 - PERFECT


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

  SCS RUNOFF CURVE NUMBER            =     86.00
  FRACTION OF AREA ALLOWING RUNOFF   =     75.0    PERCENT
  AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
  EVAPORATIVE ZONE DEPTH             =      9.0    INCHES
  INITIAL WATER IN EVAPORATIVE ZONE  =      1.944  INCHES
  UPPER LIMIT OF EVAPORATIVE STORAGE =      4.077  INCHES
  LOWER LIMIT OF EVAPORATIVE STORAGE =      0.765  INCHES
  INITIAL SNOW WATER                 =      0.000  INCHES
  INITIAL WATER IN LAYER MATERIALS   =     85.458  INCHES
  TOTAL INITIAL WATER                =     85.458  INCHES
  TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BALTIMORE             MARYLAND

    STATION LATITUDE                        =  39.18 DEGREES
    MAXIMUM LEAF AREA INDEX                 =   0.00
    START OF GROWING SEASON (JULIAN DATE)   =    102
    END OF GROWING SEASON (JULIAN DATE)     =    300
    EVAPORATIVE ZONE DEPTH                  =   9.0  INCHES
    AVERAGE ANNUAL WIND SPEED               =   9.30 MPH
```

```
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  62.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  65.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  71.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  68.00 %


        NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
        3.47        3.02        3.93        3.00        3.89        3.43
        3.85        3.74        3.98        3.16        3.12        3.35


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND

          NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       32.40       35.50       43.70       53.20       62.80       71.70
       76.50       74.50       67.40       55.30       45.50       36.60


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    BALTIMORE           MARYLAND
                   AND STATION LATITUDE  =  39.18 DEGREES




*******************************************************************************

                 MONTHLY TOTALS (IN INCHES) FOR YEAR    1
-------------------------------------------------------------------------------

                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.00    1.42    3.53    1.61    2.69    4.35
                                 2.02    3.97    7.14    4.15    3.78    7.35

RUNOFF                           0.001   0.000   0.000   0.000   0.000   0.017
                                 0.000   0.083   2.478   0.070   0.003   0.497

EVAPOTRANSPIRATION               1.826   1.852   2.705   2.062   1.728   4.375
                                 1.390   3.389   0.869   3.032   2.314   1.288

LATERAL DRAINAGE COLLECTED       2.7481  2.3877  1.0788  0.5675  0.5050  0.3884
```

```
  FROM LAYER  9                  0.2900  0.4587  0.2297  0.4304  3.0332  1.3731

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER 10                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                   MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.001   0.001   0.000   0.000   0.000   0.000
  TOP OF LAYER 10                0.000   0.000   0.000   0.000   0.001   0.000

STD. DEVIATION OF DAILY          0.001   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER 10        0.000   0.000   0.000   0.000   0.001   0.000

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
                                         --------       ----------    -------
  PRECIPITATION                            44.01         159756.297   100.00

  RUNOFF                                    3.148         11428.088     7.15

  EVAPOTRANSPIRATION                       26.832         97400.617    60.97

  DRAINAGE COLLECTED FROM LAYER  9         13.4904        48970.156    30.65

  PERC./LEAKAGE THROUGH LAYER 10            0.000002          0.009     0.00

  AVG. HEAD ON TOP OF LAYER 10              0.0004

  CHANGE IN WATER STORAGE                   0.539          1957.462     1.23

  SOIL WATER AT START OF YEAR              85.466        310240.250

  SOIL WATER AT END OF YEAR                86.005        312197.687

  SNOW WATER AT START OF YEAR               0.000             0.000     0.00

  SNOW WATER AT END OF YEAR                 0.000             0.000     0.00

  ANNUAL WATER BUDGET BALANCE               0.0000           -0.041     0.00

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        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                   2.00     1.42     3.53     1.61     2.69     4.35
                            2.02     3.97     7.14     4.15     3.78     7.35

   STD. DEVIATIONS          0.00     0.00     0.00     0.00     0.00     0.00
                            0.00     0.00     0.00     0.00     0.00     0.00

 RUNOFF
 ------
   TOTALS                   0.001    0.000    0.000    0.000    0.000    0.017
                            0.000    0.083    2.478    0.070    0.003    0.497

   STD. DEVIATIONS          0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                   1.826    1.852    2.705    2.062    1.728    4.375
                            1.390    3.389    0.869    3.032    2.314    1.288

   STD. DEVIATIONS          0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

 LATERAL DRAINAGE COLLECTED FROM LAYER  9
 ----------------------------------------
   TOTALS                   2.7481   2.3877   1.0788   0.5675   0.5050   0.3884
                            0.2900   0.4587   0.2297   0.4304   3.0332   1.3731

   STD. DEVIATIONS          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER 10
 ------------------------------------
   TOTALS                   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER 10
 -------------------------------------
   AVERAGES                 0.0009   0.0009   0.0004   0.0002   0.0002   0.0001
                            0.0001   0.0001   0.0001   0.0001   0.0010   0.0004
```

```
   STD. DEVIATIONS          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    1
-------------------------------------------------------------------------------
                                        INCHES            CU. FEET     PERCENT
                                  -------------------   -------------  ---------
 PRECIPITATION                      44.01    (   0.000)     159756.3    100.00

 RUNOFF                              3.148   (  0.0000)      11428.09     7.153

 EVAPOTRANSPIRATION                 26.832   (  0.0000)      97400.62    60.968

 LATERAL DRAINAGE COLLECTED         13.49040 (  0.00000)     48970.156   30.65304
   FROM LAYER  9

 PERCOLATION/LEAKAGE THROUGH         0.00000 (  0.00000)         0.009    0.00001
   LAYER 10

 AVERAGE HEAD ON TOP                 0.000 (    0.000)
   OF LAYER 10

 CHANGE IN WATER STORAGE             0.539   (  0.0000)       1957.46     1.225

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             PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
  ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------    -------------
     PRECIPITATION                            6.16        22360.799

     RUNOFF                                   2.478        8995.4043

     DRAINAGE COLLECTED FROM LAYER  9         0.28392      1030.63098

     PERCOLATION/LEAKAGE THROUGH LAYER 10     0.000000        0.00002

     AVERAGE HEAD ON TOP OF LAYER 10          0.003

     MAXIMUM HEAD ON TOP OF LAYER 10          0.005

     LOCATION OF MAXIMUM HEAD IN LAYER  9
           (DISTANCE FROM DRAIN)              0.0 FEET

     SNOW WATER                               0.77         2798.9209


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.3698

     MINIMUM VEG. SOIL WATER (VOL/VOL)                0.0850


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

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                 FINAL WATER STORAGE AT END OF YEAR    1
   ----------------------------------------------------------------------
                 LAYER        (INCHES)       (VOL/VOL)
                 -----        --------       ---------
                   1           2.6619          0.2218

                   2          29.7133          0.0774

                   3           3.4100          0.2842

                   4          22.3859          0.0777

                   5           3.5208          0.2934

                   6           7.0153          0.0731

                   7          11.8624          0.2471

                   8           5.4262          0.2261

                   9           0.0016          0.0105

                  10           0.0000          0.0000

                 SNOW WATER    0.000

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