2021 Design, Operations and Closure Plan

Northwin Landfill
Upland Pit Property
Campbell River, British Columbia

Upland Excavating Ltd.

GHD | 138 East 7th Avenue Suite 100 Vancouver British Columbia V5T 1M6 Canada

088877 | Report No 14 | July 8, 2021

Appendices

Appendix A
Operational Certificate

August 1, 2019

Tracking Number: 335965
Authorization Number: 107689

REGISTERED MAIL

UPLAND EXCAVATING LTD.
#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Dear operational certificate holder:

Enclosed is Operational Certificate 107689 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit and Approval Fees and Charges Regulation.

This operational certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the operational certificate holder. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

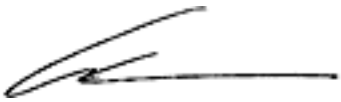
Requirements may also be specified by the *Environmental Management Act* and regulations including, but not limited to, the Contaminated Sites Regulation, Environmental Data Quality Assurance Regulation, Hazardous Waste Regulation, Landfill Gas Management Regulation, Organic Matter Recycling Regulation, Ozone Depleting Substances and Other Halocarbons Regulation, Recycling Regulation, Spill Reporting Regulation, Storage of Recyclable Material Regulation, Waste Discharge Regulation and Codes of Practice.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this operational certificate will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Documents pertinent to the operational certificate are to be submitted by email or electronic transfer to the director, in accordance with the ministry Data & Report Submissions website at: http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions, or as further instructed.

If you have any questions or concerns, please contact Authorizations - South at Authorizations.South@gov.bc.ca.

Yours truly,



Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

Enclosure

MINISTRY OF ENVIRONMENT &
CLIMATE CHANGE STRATEGY

OPERATIONAL CERTIFICATE

107689

Under the Provisions of the Environmental Management Act

Pursuant to the Approved

Comox Valley Regional District Solid Waste Management Plan

UPLAND EXCAVATING LTD.

#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Is authorized to manage waste at the Facility located in Campbell River, British Columbia, subject to the requirements listed below. Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

Pursuant to section 24(10) of the *Environmental Management Act*, this operational certificate supersedes and cancels Permit PR-10807 issued under section 14 of the *Environmental Management Act*.

1. AUTHORIZED DISCHARGES, FACILITIES AND WORKS

1.1 Original Landfill

This section applies to the Original Landfill.

1.1.1 The maximum rate of waste discharge to the Original Lined Cell is 45,000 tonnes per calendar year.

1.1.2 The characteristics of the waste discharge to the Original Lined Cell must be:

(a) demolition waste,
(b) construction waste,
(c) land clearing waste,
(d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
(i) the generic numerical soil standards,
(ii) the matrix numerical soil standards, or

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for Director, *Environmental Management Act*
Authorizations - South Region

(iii) a director's interim standard for soil,
referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96,
(e) sludge from the Original Leachate Management Works, or,
(f) other waste as authorized in writing by the director,
but does not include:
(g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and,
(h) waste and/or recyclable material prohibited in writing by the director.

1.1.3 The waste discharge is authorized to the Original Lined Cell approximately located as shown on Site Plan A. Waste discharge to the Original Un-Lined Cell is not authorized.

1.1.4 Authorization to discharge waste to the Original Lined Cell ceases on the earlier of:
(i) the date the Original Lined Cell is filled to capacity with grades not steeper than 3H:1V (33%),
(ii) the date of commencement of waste discharge to the New Landfill.

1.1.5 The authorized works are:
(i) a lined landfill footprint with a maximum area of 0.72 ha (85 m x 85 m) including from bottom to top a base with perimeter berm, 0.3 m sand cushion layer, 0.5 mm thick coated woven polyethylene liner, 0.3 m granular leak detection layer, leak detection riser pipe, 0.5 mm thick coated woven polyethylene liner, 0.3 m sand protection layer, leachate extraction chamber, final cover, and,
(ii) an un-lined landfill footprint with an approximate area of 0.7 ha, final cover,
and related appurtenances, approximately located as shown on Site Plan A.

1.1.6 The operational certificate holder must ensure the Original Landfill, excluding final cover, is complete and fully operational on or before the date of issuance of this operational certificate, and at all times thereafter, until the Original Landfill is decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.2 **Original Leachate Management Works**

This section applies to the management of leachate from the Original Lined Cell.

1.2.1 The operational certificate holder must convey the leachate from the Original Lined Cell, that is to be discharged on the Facility site, to the Original Leachate Management Works.

1.2.2 The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 7,139 m^3 per calendar year.

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for Director, *Environmental Management Act*
Authorizations - South Region

1.2.3 The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.2.4 The treated leachate effluent is authorized to be discharged to the treated leachate infiltration pond and infiltrated into the ground. This authorization ceases on the date the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.2.5 The authorized works are leachate conveyance, storage, treatment and discharge works including pumps, pipes, leachate storage and treatment tanks, treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.

1.2.6 Minimum Freeboard must be maintained at all times as follows:
treated leachate infiltration pond: 0.6 m

1.2.7 The operational certificate holder must ensure the Original Leachate Management Works are complete and fully operational on or before the date of commencement of discharge to the treated leachate infiltration pond, and at all times thereafter, until the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.3 **New Landfill**

This section applies to the New Landfill.

1.3.1 The maximum rate of waste discharge to the New Landfill is: (45,000 minus the waste discharge to the Original Lined Cell) tonnes per calendar year.

1.3.2 The characteristics of the waste discharge to the New Landfill must be:
(a) demolition waste,
(b) construction waste,
(c) land clearing waste,
(d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
(i) the generic numerical soil standards,
(ii) the matrix numerical soil standards, or
(iii) a director's interim standard for soil,
referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96,
(e) sludge from the New Leachate Management Works or the New Stormwater

Management Works, or,

(f) other waste as authorized in writing by the director,

but does not include:

(g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and,

(h) waste and/or recyclable material prohibited in writing by the director.

1.3.3 The waste discharge is authorized to the New Landfill approximately located as shown on Site Plan A.

1.3.4 The authorized works are a lined landfill footprint with a maximum area of 3.60 ha including from bottom to top a base with perimeter berm, secondary base liner, leak detection drainage layer and leak collection pipes and sump, primary base liner, leachate collection drainage layer and leachate collection pipes and sump, pumps, pipes, final cover, and related appurtenances, approximately located as shown on Site Plan A.

1.3.5 The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1×10^{-7} cm/s. However, on the south slope of the base more than 1 m above the primary base liner, the geosynthetic clay liners are not required.

1.3.6 The operational certificate holder must ensure the New Landfill, excluding final cover, is complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.4 New Leachate Management Works

This section applies to the management of leachate from the New Landfill.

1.4.1 The operational certificate holder must convey the leachate from the New Landfill, that is to be discharged on the Facility site, to the New Leachate Management Works.

1.4.2 The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 24,633 m^3 per calendar year.

1.4.3 The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.4.4 The treated leachate effluent is authorized to be discharged to the treated leachate infiltration

pond and infiltrated into the ground.

1.4.5 The authorized works are leachate conveyance, treatment and discharge works including pumps, pipes, leachate treatment pond(s), treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.

1.4.6 The leachate treatment pond(s) must include from bottom to top a secondary base liner, leak detection drainage layer and leak collection pipe(s), and a primary base liner. The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1×10^{-7} cm/s.

1.4.7 Minimum Freeboard must be maintained at all times as follows:
leachate treatment pond(s): 0.6 m
treated leachate infiltration pond: 0.6 m

1.4.8 The operational certificate holder must ensure the New Leachate Management Works are complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.5 **New Stormwater Management Works**

This section applies to the management of stormwater from the New Landfill.

1.5.1 The operational certificate holder must manage stormwater from the New Landfill such that stormwater is infiltrated into the ground with the authorized works.

1.5.2 The stormwater must not include leachate and the concentration of any substance in the stormwater must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.5.3 The authorized works are diversion berm, perimeter berm, mid slope swales, drop down channels, ditches, energy dissipation and sediment traps, stormwater infiltration area, and related appurtenances approximately located as shown on Site Plan A.

1.5.4 Minimum Freeboard must be maintained at all times as follows:
stormwater infiltration area: 0.6 m
all other authorized works: 0.3 m

1.5.5 The operational certificate holder must ensure that adequate authorized works to manage stormwater, such that stormwater is infiltrated into the ground with the authorized works, are

complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.6 Facility Entrance

This section applies to the Facility entrance.

1.6.1 The authorized works are sign(s), gate, fence, weigh scale, and related appurtenances approximately located as shown on Site Plan A.

1.6.2 The operational certificate holder must ensure the authorized works are complete and fully operational on or before the date of issuance of this operational certificate and at all times thereafter.

1.7 Location of Facility

This section applies to the location of the Facility.

1.7.1 The location of the Facility is PID 001-223-321, LOT A, DISTRICT LOT 85, SAYWARD DISTRICT, PLAN 30709 EXCEPT PART IN PLAN EPP15087, approximately located as shown on Site Plan A.

2. GENERAL REQUIREMENTS

2.1 Glossary

The following capitalized terms referred to in this authorization are defined in the Glossary below. Other terms used in this authorization have the same meaning as those defined in the *Environmental Management Act*, applicable regulations, and the Landfill Criteria;

"Attractant" means food or food waste, compost, carcass or part of an animal, fish, or other meat, or other waste or garbage, that could attract bears, birds, rodents, insects, vectors or wildlife, but does not include grass, leaves, weeds, branches and woodwaste;

"Facility" means the Original Landfill, Original Leachate Management Works, New Landfill, New Leachate Management Works, New Stormwater Management Works and the authorized works in section 1.6.1 (Facility Entrance) of this operational certificate;

"Freeboard" means the difference in elevation between the contained liquid level and the top of the containment works at its lowest point;

"Landfill Criteria" means the Landfill Criteria for Municipal Solid Waste Second Edition June 2016, as amended or replaced from time to time;

"New Landfill" means the authorized works in section 1.3.4 of this operational certificate;

"New Leachate Management Works" means the authorized works in section 1.4.5 of this operational certificate;

"New Stormwater Management Works" means the authorized works in section 1.5.3 of this operational certificate;

"Original Landfill" means the Original Lined Cell and the Original Un-Lined Cell;

"Original Leachate Management Works" means the authorized works in section 1.2.5 of this operational certificate;

"Original Lined Cell" means the authorized works in section 1.1.5(i) of this operational certificate;

"Original Un-Lined Cell" means the authorized works in section 1.1.5(ii) of this operational certificate;

"Province" means Her Majesty the Queen in right of British Columbia;

"Regulatory Document" means any document that the operational certificate holder is required to cause to be prepared, prepare or submit to the director or the Province, pursuant to: (i) this authorization; (ii) any regulation made under the *Environmental Management Act* that regulates the Facility described in this authorization or the discharge of waste from that Facility; or (iii) any order issued under the *Environmental Management Act* directed against the operational certificate holder that is related to the Facility described in this authorization or the discharge of waste from that Facility;

"Significant Works" means the Facility excluding the authorized works in section 1.6.1 (Facility Entrance) of this operational certificate.

2.2 **Use of Qualified Professional(s)**

The operational certificate holder must cause a Qualified Professional to:

(a) Design and inspect the construction of the Facility, and,

(b) Certify documents related to the Facility including plans, specifications, drawings, construction

reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings.

(d) Submit a completed Declaration of Competency and a Conflict of Interest Disclosure Statement with each document.

2.3 Operations and Closure Plan (OCP)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date OCP for the Original Landfill and the Original Leachate Management Works, to the director, on or before the earlier of:

(i) 30 days before the date of commencement of waste discharge to the Original Lined Cell,
(ii) 30 days after the date of issuance of this operational certificate.

(b) The OCP must comply with the requirements of this operational certificate, include information specified in relevant items listed in the Landfill Criteria Section 10.3 Design, Operations and Closure Plan including a site layout plan, a filling plan, a lifespan analysis table, a stormwater management plan, a leachate management plan, an environmental monitoring plan, an operations plan, a closure plan, and the information specified in the following sections of this operational certificate:

2.7(a) (soil acceptance plan), and,
2.10(a) (financial security plan).

(c) The operational certificate holder must carry out the most recent OCP and design, construct, operate, inspect, maintain, monitor and close the Original Landfill and the Original Leachate Management Works, in compliance with the most recent OCP and this operational certificate, until the Original Landfill and the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

2.4 Hydrogeology and Hydrology Characterization Report (HHCR)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date HHCR, to the director, on or before 90 days before the date of commencement of waste discharge to the New Landfill.

(b) The HHCR must include characterization of the geology, hydrogeology, and surface hydrology at and near the Facility site, and the information specified in all the items listed in the Landfill Criteria, section 10.1 Hydrogeology and Hydrology Characterization Report.

(c) The operational certificate holder must cause a Qualified Professional to certify and submit an updated HHCR to the director, at least once every five years after the date of commencement of waste

discharge to the New Landfill.

2.5 **Design, Operations and Closure Plan (DOCP)**

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date DOCP, for the Facility, to the director, on or before 90 days before the date of commencement of waste discharge to the New Landfill.

(b) The DOCP must comply with the requirements of this operational certificate, include the information specified in all the items listed in the Landfill Criteria Section 10.3 Design, Operations and Closure Plan, and the information specified in the following sections of this operational certificate:

2.6(a) (New Leachate Management Works commissioning plan),
2.7(a) (soil acceptance plan),
2.8(a) (trigger level assessment plan),
2.9(a) (plan to remove all waste from the Original Landfill), and,
2.10(b) (financial security plan).

(c) The operational certificate holder must cause a Qualified Professional to certify and submit an updated DOCP to the director, as necessary to keep the DOCP up to date, at least once every five years after the date of commencement of waste discharge to the New Landfill.

(d) The operational certificate holder must carry out the most recent DOCP and design, construct, operate, inspect, maintain, monitor, and close the Facility, in compliance with most recent DOCP and this operational certificate.

2.6 **New Leachate Management Works Commissioning Plan and Report**

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a New Leachate Management Works commissioning plan that includes:

(i) the expected duration of the New Leachate Management Works commissioning period,
(ii) description of the New Leachate Management Works and design, including treatment of leachate from soil and treated leachate infiltration pond design and infiltration tests,
(iii) the monitoring, sampling and analyses that will be carried out during the New Leachate Management Works commissioning period including the quantity and quality of leachate and treated leachate effluent, and confirmatory sampling before the discharge of any treated leachate effluent to the treated leachate infiltration pond,
(iv) operating procedures that will be carried out during the New Leachate Management Works commissioning period including review of confirmatory sampling results before the discharge of any treated leachate effluent to the treated leachate infiltration pond,
(v) contingency measures that will be carried out during the New Leachate Management Works

commissioning period if the treated leachate effluent quality does not comply with this operational certificate, including storage, retreatment, and transport to an off-site authorized treatment facility,
(vi) New Leachate Management Works commissioning report description, table of contents and summary of contents.

(b) The operational certificate holder must cause a Qualified Professional to certify and submit a New Leachate Management Works commissioning report, that includes the information contemplated in section 2.6(a)(vi) of this operational certificate, to the director, on or before 30 days after the completion of the New Leachate Management Works commissioning period, or as specified by the director.

2.7 **Soil Acceptance Plan**

(a) The OCP submitted pursuant to section 2.3, and the DOCP submitted pursuant to section 2.5, of this operational certificate, must include a soil acceptance plan that includes procedures that will be carried out before soil is accepted at the Facility including receipt and review of documents required by section 2.7(b) of this operational certificate, and consideration of the applicable Original Leachate Management Works or New Leachate Management Works adequacy to treat leachate from the soil.

(b) Before a specific quantity of soil is accepted at the Facility, the operational certificate holder must cause a Qualified Professional to certify and submit to the operational certificate holder, a document pertaining to the specific quantity of soil that includes:
(i) the soil tonnage(s) and soil quality class(es) as described in the most recent version of Technical Guidance 1 on Contaminated Sites Site Characterization and Confirmation Testing,
(ii) the soil origin including applicable civic address, site identification number, parcel identifier, parcel identification number, legal description, and,
(iii) characterization of the soil in accordance with ministry procedures and applicable Contaminated Sites Regulation Guidance, Protocols and Procedures.

2.8 **Trigger Level Assessment Plan**

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a trigger level assessment plan that includes:
(i) Description of the routine monitoring of the quantity and quality of leachate leakage through the primary liner and into the leak detection layer for the New Landfill, and for the leachate treatment pond(s), and related leachate leakage quantities and qualities that will trigger corresponding described increased monitoring, investigations, contingency measures and actions.
(ii) Description of the routine monitoring of groundwater quality immediately downgradient of the New Landfill, the leachate treatment pond(s), and the treated leachate infiltration pond, and related groundwater substance concentrations that will trigger corresponding described increased

monitoring, investigations, contingency measures and actions.

2.9 Plan to Remove all Waste from the Original Landfill

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a plan to remove all waste from the Original Landfill, categorize such waste, discharge all such waste to the New Landfill or to other identified and authorized waste management facility(ies), carry out sampling to confirm all such waste has been removed, and decommission the Original Landfill and the Original Leachate Management Works.

(b) Subject to section 1.3.2 of this operational certificate, waste removed from the Original Landfill is authorized to be discharged to the New Landfill. The tonnage of such waste must not be included for the purpose of determining compliance with section 1.3.1 of this operational certificate.

(c) The director may require the operational certificate holder to carry out and complete the plan referred to in section 2.9(a) of this operational certificate, in accordance with the director's requirements.

(d) If the plan referred to in section 2.9(a) of this operational certificate is carried out, the operational certificate holder must cause a Qualified Professional to certify and submit a report to the director that confirms that the plan has been carried out and completed in accordance with the director's requirements, describes the plan implementation, describes and provides the waste categorization, describes and provides the sampling and results, describes the decommissioning of the Original Landfill and the Original Leachate Management Works, provides photos documenting the implementation of the plan referred to in section 2.9(a) of this operational certificate, and lists the tonnages or volumes, and categories of waste removed and discharged to the New Landfill and to other identified and authorized waste management facility(ies), on or before 60 days after the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed.

2.10 Financial Security

(a) The OCP submitted pursuant to section 2.3 of this operational certificate must include a financial security plan that includes:

(i) the calculations of the amounts of financial security and time periods for each phase of development for the Original Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,

(ii) the amounts of financial security for the corresponding time periods.

(b) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a financial security plan that includes:

(i) the tasks, estimated costs, contingency costs, calculations of the amounts of financial security

and time periods, to carry out and complete the plan referred to in section 2.9(a) of this operational certificate (plan to remove all waste from the Original Landfill),
(ii) the calculations of the amounts of financial security and time periods for each phase of development for the New Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,
(iii) the amounts of financial security for the corresponding time periods.

(c) The operational certificate holder must provide the director with financial security, on or before the earlier of:
(i) 30 days before the date of commencement of waste discharge to the Original Lined Cell,
(ii) 30 days after the date of issuance of this operational certificate,
(iii) 90 days before the date of commencement of waste discharge to the New Landfill,
and at all times thereafter.

(d) The amount of financial security at any time must be equal to or greater than:
(i) Before the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the greater amount specified for the corresponding time period in:
- the financial security plan in the most recent OCP,
- the financial security plan in the most recent DOCP.
(ii) On and after the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the amount specified for the corresponding time period in the financial security plan in the most recent DOCP.

(e) The form of financial security must be satisfactory to the director.

(f) At the discretion of the director, such financial security may be used among other things:
(i) to correct any inadequacy of the Facility relating to its design, construction, operation, inspection, maintenance, monitoring, closure, and post-closure;
(ii) to correct any default in compliance with this operational certificate or the *Environmental Management Act*; and,
(iii) for remediation of the Facility.

(g) The operational certificate holder must replenish any amounts drawn from the posted financial security within 60 days of such amounts being drawn or as otherwise specified by the director.

2.11 **Construction Report(s)**

(a) The operational certificate holder must cause a Qualified Professional to carry out inspections

before and during the construction or modification of Significant Works, and, after the completion of construction or modification of Significant Works, to certify and submit construction report(s) to the director:

(i) for construction of the New Landfill and the New Leachate Management Works, on or before 30 days before the date of commencement of waste discharge to those new Significant Works, and,
(ii) for all Significant Works, on or before 60 days after the completion of construction or modification of the Significant Works.

(b) The construction report(s) must demonstrate that the Significant Works have been constructed in accordance with this operational certificate and the applicable most recent OCP or DOCP, describe any technical concerns that arose from the inspections and testing and how they were addressed, and include as-built record drawings of the constructed Significant Works, all the inspection and testing reports and results including geologic inspection report, quality control and quality assurance testing, soil test data including field and laboratory data, as described in the Landfill Criteria section 10.2 Construction Report(s).

2.12 **Notification of Commencement of Waste Discharge**

The operational certificate holder must notify the director of:
(a) the date of commencement of waste discharge to the Original Lined Cell, on that date,
(b) the date of commencement of waste discharge to the New Landfill, on that date,
(c) the date the Original Lined Cell has reached capacity, on that date, and,
(d) the date the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed, on that date.

2.13 **Buffer Zone**

The operational certificate holder must ensure that the New Landfill, New Leachate Management Works, and New Stormwater Management Works, are located a minimum of 50 m from the Facility site boundary.

2.14 **Depth to Groundwater**

The operational certificate holder must ensure that the New Landfill secondary base liner, and the New Leachate Management Works leachate treatment pond(s) secondary base liner, are a minimum of 1.5 m above groundwater at all times.

2.15 **Covenant**

On or before the date of commencement of waste discharge to the New Landfill, the operational certificate holder must register a covenant under section 219 (1) of the *Land Title Act*, in a form

acceptable to the director, that binds successors in title to uphold the continued implementation of the closure plan in the most recent DOCP, and prohibits development of the Facility other than as contemplated by this operational certificate or approved by the director. Such covenant must include an acknowledgement that the property was used for the purpose of waste disposal, must be registered as a charge against title to the property on which the facility is located and must be registered in priority to all charges except charges which do not give the holders any rights which might conflict with the covenant.

2.16 Additional Requirements

The director may require the operational certificate holder to:

(a) Cause a Qualified Professional to certify and submit to the director additional, amended or improved documents of the Facility including plans, specifications, drawings, construction reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings.

(b) Carry out actions in accordance with the additional, amended or improved documents submitted, and additional actions as specified.

(c) Repair, alter, remove, improve or add to existing facilities and works, or construct new facilities and works, at the Facility.

(d) Temporarily or permanently cease waste discharge to the Original Lined Cell and/or the New Landfill, cover part(s) or all of the Original Landfill and/or the New Landfill with final cover, and close and decommission the Facility, as specified.

2.17 Authorization Requirements

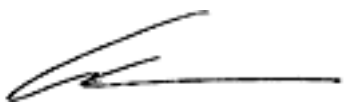
Where this authorization provides that the director may specify a matter or require an action to be carried out, the operational certificate holder must comply with the specification and carry out the action in accordance with the requirements of the director.

3. OPERATING AND PERFORMANCE REQUIREMENTS

3.1 Multiple and/or Spare Works and Auxiliary Power Facilities

The operational certificate holder must provide and install multiple and/or spare works and auxiliary power facilities to ensure the Original Lined Cell, Original Leachate Management Works, New Landfill, New Leachate Management Works, and New Stormwater Management Works, are complete and fully operational as specified in this operational certificate, including during maintenance, breakdowns and electrical power outages.

Date issued: August 1, 2019



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3.2 **Maintenance of the Facility**

(a) The operational certificate holder must cause persons that are qualified and trained to operate, regularly inspect, and maintain the Facility, in good working order. If components of the Facility have a manufacturer's recommended maintenance schedule, then those components must, at a minimum, be maintained in accordance with that schedule.

(b) The operational certificate holder must prepare documents of the qualification and training of the persons operating, inspecting and maintaining the Facility, and of Facility inspections, operation and maintenance.

3.3 **Facility Manager and Operator Certification**

(a) The operational certificate holder must ensure that at least one person responsible for the management of the Facility is certified, and maintains certification, by The Solid Waste Association of North America (SWANA) as a Manager of Landfill Operations, and at least one person responsible for the operation of the Facility has, within the preceding five years, successfully completed the SWANA Landfill Operations Basics course, on or before the earlier of:

(i) the date of commencement of waste discharge to the Original Lined Cell,

(ii) the date of commencement of waste discharge to the New Landfill,

and at all times thereafter.

(b) The operational certificate holder must prepare documents of the SWANA certification and training of the person(s) responsible for the management and operation of the Facility.

3.4 **New Leachate Management Works Classification and Operator Certification**

(a) The operational certificate holder must have the New Leachate Management Works classified by the Environmental Operators Certification Program (EOCP), on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

(b) The operational certificate holder must ensure that the person(s) responsible for the operation and maintenance of the New Leachate Management Works is(are) certified at an EOCP certification level equivalent to or higher than the EOCP classification level of the New Leachate Management Works, on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

(c) The operational certificate holder must prepare documents of the EOCP classification level of the New Leachate Management Works and the EOCP certification level(s) of the person(s) responsible for the operation and maintenance of the New Leachate Management Works.

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3.5 Groundwater Quality

(a) The operational certificate holder must ensure that the Facility does not cause the concentration of any substance in groundwater flowing from the Facility site boundary to be greater than:

(i) the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance,

or,

(ii) if the local background concentration of any substance is greater than (i), the local background concentration of that substance.

(b) If section 3.5(a)(ii) of this operational certificate is being used, the operational certificate holder must cause a Qualified Professional to determine the local background concentration of substance(s) in (a), in accordance with the latest approved version of Protocol 9 for Contaminated Sites, Determining Background Groundwater Quality, and include such determination(s) in the Annual Operations and Monitoring Report.

(c) The director may specify more stringent groundwater quality standards than those set out in this section.

3.6 Landfill Gas Management

The operational certificate holder must ensure that:

(a) The Facility does not cause:

(i) combustible gas concentrations to exceed the lower explosive limit of methane (5 percent by volume), or a lower concentration specified by the director, in soil at the Facility site boundary;

(ii) combustible gas concentrations to exceed 20 percent of the lower explosive limit of methane (1 percent by volume) in any building; and

(iii) federal, provincial, or local ambient air quality objectives and standards to be exceeded in air at the Facility site boundary.

(b) Landfill gas is managed in accordance with all migration and health and safety requirements.

3.7 Nuisance

The operational certificate holder must ensure that the Facility does not cause a nuisance including with regard to birds, rodents, insects, odour, noise, dust, litter, vector and wildlife attraction.

3.8 Complaints

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The operational certificate holder must prepare documents of complaints with regard to matters relevant to this operational certificate, including environmental and nuisance complaints. These documents must include the source and nature of the complaint, actions, responses, and corresponding dates and times.

3.9 Regulatory Documents

(a) The operational certificate holder must retain all Regulatory Documents.

(b) The operational certificate holder must retain all Regulatory Documents for the last seven years at the Facility and such documents must be available for immediate inspection at the Facility by a director or an officer.

(c) If requested by a director or an officer, the operational certificate holder must submit the requested Regulatory Documents to the director or officer within 14 days of the request.

4. SAMPLING REQUIREMENTS

4.1 Sampling Procedures

The operational certificate holder must carry out required sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

4.2 Analytical Procedures

The operational certificate holder must carry out required analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

4.3 Quality Assurance

(a) The operational certificate holder must obtain from the analytical laboratory(ies) their precision, accuracy and blank data for each sample set submitted by the operational certificate holder and an evaluation of the data acceptability, based on criteria set by such laboratory.

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(b) The operational certificate holder must submit samples to analytical laboratory(ies) that meet the definition of a qualified laboratory under the Environmental Data Quality Assurance Regulation.

(c) The operational certificate holder must collect, prepare and submit for analysis by the analytical laboratory(ies) quality control (QC) samples for each parameter. As a minimum,

(i) The number of QC samples should be 20% of all samples collected (environmental + QC samples) within 48 hours of each other, and

(ii) Include duplicate, field and trip blank samples for each parameter.

5. REPORTING REQUIREMENTS

5.1 Routine Reporting

The operational certificate holder must submit all routine Regulatory Documents required by this operational certificate by email to the Ministry's Routine Environmental Reporting Submission Mailbox at EnvAuthorizationsReporting@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox.

5.2 Non-compliance Notification

(a) The operational certificate holder must immediately notify the director or designate by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director of any non-compliance with the requirements of this authorization by the operational certificate holder and must take remedial action to remedy any effects of such non-compliance.

(b) The operational certificate holder must provide the director with written confirmation of all such non-compliance events, including available test results within 24 hours of the original notification by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director.

5.3. Non-compliance Reporting

(a) If the operational certificate holder fails to comply with any of the requirements of this authorization, the operational certificate holder must, within 30 days of such non-compliance, submit to the director a written report that is satisfactory to the director and includes, but is not necessarily limited to, the following:

(i) all relevant test results obtained by the operational certificate holder related to the non-compliance,

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(ii) an explanation of the most probable cause(s) of the non-compliance, and
(iii) a description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future.

(b) The operational certificate holder must submit all non-compliance reporting required to be submitted under this section by email to the Ministry's Compliance Reporting Submission Mailbox at EnvironmentalCompliance@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to report a non-compliance or for more information visit the Ministry website http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/non-compliance-reporting-mailbox.

5.4 **Annual Operations and Monitoring Report**

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an Annual Operations and Monitoring Report in a format suitable for public release, for the preceding calendar year, to the director on or before March 31 of each year. On or before March 31 of each year, the operational certificate holder must post a copy of the Annual Operations and Monitoring Report online, on a website accessible to the public, and in accordance with any requirements of the director.

(b) The Annual Operations and Monitoring Report must include the following information:
Operations Report:
(i) Summary of OCP implementation that addresses the information in section 2.3(b), and summary of DOCP implementation that addresses the information in 2.5(b), of this operational certificate,
(ii) Summary of construction report(s),
(iii) Annual and cumulative tonnages and categories of waste including soil tonnage(s) and soil quality class(es) discharged to the Original Lined Cell and to the New Landfill,
(iv) Remaining volume and life of the Original Lined Cell and of the New Landfill,
(v) Summary of treated leachate effluent quantity and quality discharged to the treated leachate infiltration pond,
(vi) Summary of complaints and nuisances and description of remedial action planned and/or taken by the operational certificate holder to prevent similar complaints and nuisances in the future,
(vii) Summary of non-compliance notifications and non-compliance reporting and description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future ,
(viii) Annual status form in accordance with the instructions and template at the ministry website https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/annual-status-form
(ix) Summary of OCP and DOCP implementation, and construction of Significant Works, planned for the next calendar year,

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Environmental Monitoring Plan Report:

(x) Site plan(s), sampling locations, stormwater flow paths, groundwater elevations, gradients and flow directions,
(xi) Sampling facilities, frequencies, substances, sampling and analytical procedures,
(xii) Data including laboratory analysis and quality assurance and quality control results,
(xiii) Data tabulation, trend analysis, graphs, diagrams, and interpretation,
(xiv) Trigger level assessment plan monitoring, data, results and interpretation,
(xv) Any determination(s) of the local background concentration of substance(s) in accordance with section 3.5 of this operational certificate,
(xvi) Comparison of the data with the standards for treated leachate effluent discharge, stormwater quality, groundwater quality, and landfill gas management, specified in sections 1.2, 1.4, 1.5, 3.5 and 3.6 of this operational certificate, and identification of any non-compliance and predicted future non-compliance,
(xvii) Results, conclusions, recommendations and changes to the environmental monitoring plan.

(c) The operational certificate holder must upload monitoring data associated with this operational certificate to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the 3 month period in which the data is collected.

5.5 **Licence to Publish Documents**

(a) Subject to paragraph (b), the operational certificate holder authorizes the Province to publish on the Ministry of Environment and Climate Change Strategy website the entirety of any Regulatory Document.

(b) The Province will not publish any information that could not, if it were subject to a request under section 5 of the *Freedom of Information and Protection of Privacy Act*, be disclosed under that Act.

(c) The operational certificate holder will indemnify and save harmless the Province and the Province's employees and agents from any claim for infringement of copyright or other intellectual property rights that the Province or any of the Province's employees or agents may sustain, incur, suffer or be put to at any time that arise from the publication of a Regulatory Document.

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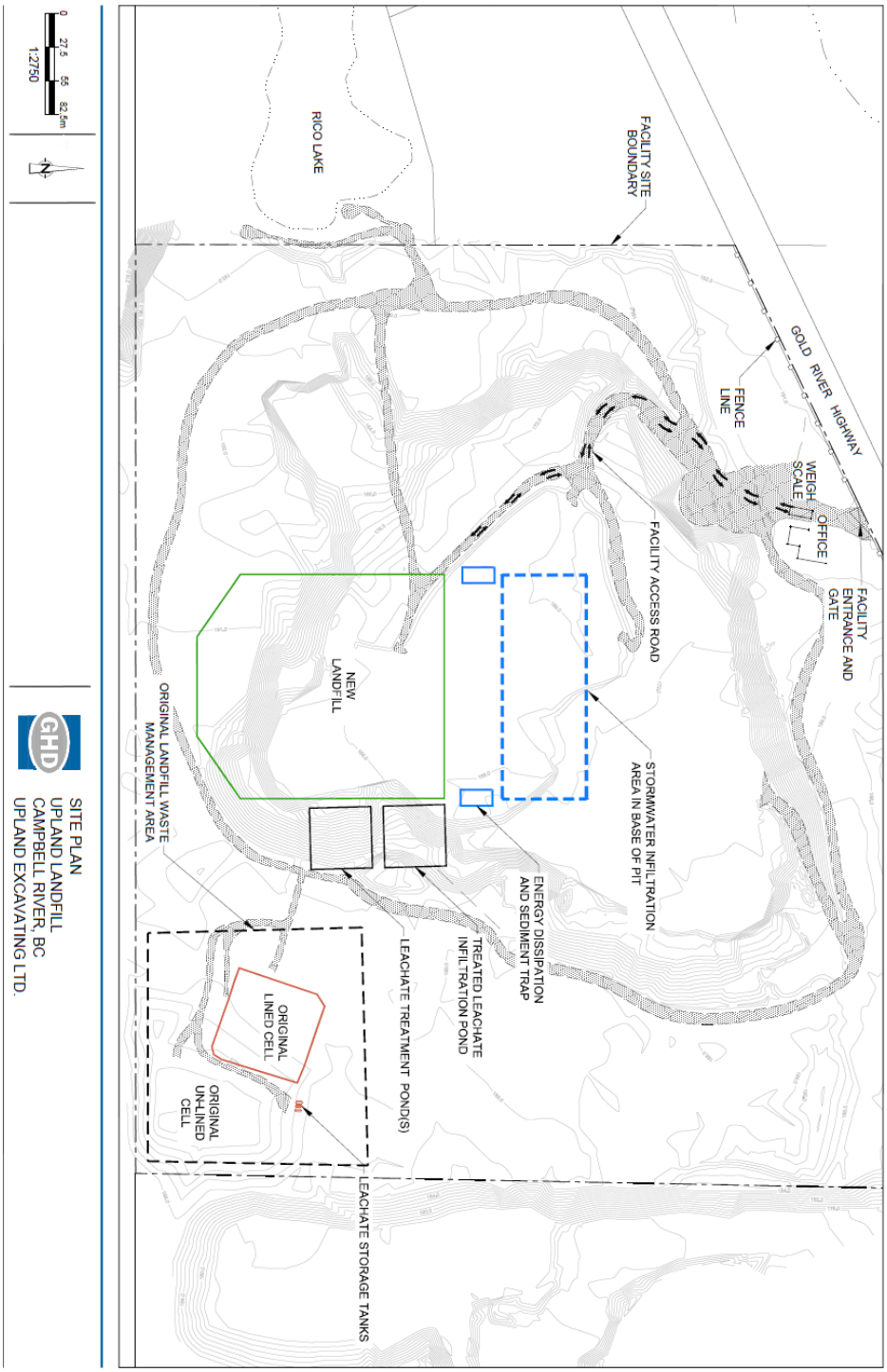
Site Plan A



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Appendix B
HDPE Geomembrane Liner Performance Review

Appendix B Liner Performance Review

1. Liner Performance Review

High-density polyethylene (HDPE) geomembranes have very high performance in containing common leachate constituents at concentrations found in landfill leachate. Geomembranes are an excellent barrier to ionic contaminants such as chloride and heavy metals, and when used in composite liners, the secondary layer provides resistance to diffusive transport of vapour phase contaminants (Rowe et al. 2004). The use of HDPE geomembranes in composite liner systems is an industry standard for all types of landfills, worldwide.

The United States Environmental Protection Agency (USEPA) promotes the use of HDPE geomembranes in composite liner systems for both hazardous and non-hazardous waste landfills (Resource Conservation and Recovery Act (RCRA) Subtitle C and Subtitle D regulations) (USOFR, 2006). The Canadian Council of Ministers of the Environment (CCME) National Guidelines for Hazardous Waste Landfills, 2006 specifies the use of HDPE geomembranes in combination with a clay layer or GCL for the containment of hazardous wastes due the complimentary properties of the two different liner materials. Many North American regulatory jurisdictions generically accept the performance life of HDPE membranes in landfill liner systems as being over 100 years, well beyond the contaminating life span of most landfills.

The Landfill has an estimated operating site life of 13 years. The Contaminating Lifespan (CLS) Assessment for the landfill as presented in the DOCP, is estimated to be 28 years and rounded up to 30 years per the Landfill Criteria requirements. The CLS is the period of time during which the Site could produce leachate contaminants at concentrations that could have an unacceptable impact if they were discharged from the Site.

1.1 Expected Leachate Quality

As in the 2020 DOCP, the Landfill will accept waste select municipal solid waste, as defined by the Environmental Management Act, and will include the following:

- Construction and demolition waste
- Land clearing debris
- Soil meeting Industrial land use standards, per the BC CSR
- Waste asbestos containing materials (ACM), managed according to Section 40 of the HWR

The Landfill leachate is expected to be characteristic of demolition, land clearing and construction (DLC) waste landfills (C&D landfills). Typically, the most potentially prominent contaminants in the leachate from C&D landfills are sulphate, arsenic, iron, manganese, and total dissolved solids (TDS). Non-hazardous contaminated soil may contain a variety of contaminants depending on the source of the waste material. Common soil contaminants include metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and petroleum hydrocarbons (PHCs). The leachability of the contaminants in non-hazardous contaminated soil is low compared to hazardous waste that may contain elevated concentrations and potentially include free-product. Soil must meet Industrial land use standards per the CSR to be accepted at the Site. ACM does not affect the quality of the leachate in terms of impacts from the asbestos material, as asbestos does not have the leachability characteristic that distinguish hazardous chemicals, identified in the HWR. Once landfilled ACM is an inert material.

HDPE geomembranes are used in landfill applications, especially for bottom liners, because of their relatively high resistance to aggressive leachate components (Rowe, 2001). However, unlike putrescible municipal solid waste (MSW), DLC waste consists largely of inorganic components and organic matter with a low degree of biodegradability. Typical concentration ranges of leachate parameters for DLC landfills are lower than for MSW (Weber et al., 2002).

Based on accepted waste management practices, and forecasted leachate quality, a composite liner consisting of an HDPE geomembrane and a GCL is an appropriate base liner for the Landfill.

1.2 HDPE Geomembrane Durability

Examinations of both laboratory and field data available in the literature indicate that the projected service lives of HDPE geomembranes may range depending on the material and exposure conditions. HDPE liner durability or lifetime is typically described as the material half-life, the time at which design properties have been reduced to 50%. The ageing process of HDPE geomembranes involves a combination of physical and chemical ageing that will, over time, eventually lead to material degradation. This sub-section describes the structure of HDPE and its potential failure mechanisms and reviews the predicted durability of the HDPE liner system in the context of the Site life and contaminating lifespan of the Landfill.

1.3 Structure of HDPE

HDPE is formulated by percentage based on weight 95 - 98% resin, 2- 3% carbon black (colourant) and 0.25 – 1% additives, such as antioxidants and other stabilizers (Rowe and Sangam, 2001). If the formulation changes (particularly the additives), the predicted lifetime will also change. The typical structure of a polyethylene consists of linked carbon atoms that are bonded to hydrogen with the molecular chains folded together to form ordered regions called lamellae (Rowe and Sangam, 2001). HDPE is defined as a semi-crystalline polymer with partially aligned molecular chains. Some of the inherent properties of HDPE depend on its molecular packing structure and therefore, changes at the molecular level many alter the durability and the overall field performance of the geomembrane (Tarnowski and Baldauf, 2006).

1.4 Failure Mechanisms

HDPE can be degraded to only a limited extent by most inorganic and organic chemicals (Tarnowski and Baldauf, 2006). Photo and/or thermo-oxidative ageing, depending on the application, is the primary cause of degradation of the polymer (Tarnowski and Baldauf, 2006). Under covered conditions in medium temperature and in the absence of UV radiation, oxidation takes place very slowly. The failure mechanisms that are potentially applicable for buried HDPE geomembranes include:

- Oxidation – is the major mechanisms of degradation in polyethylenes, including HDPE under all conditions. The polymer chains undergo reactions with oxygen leading eventually to changes in molecular structure and in morphology.
- Chemical – can occur when one or more components are removed from the material due to long-term exposure to chemicals or liquids (Rowe and Sangam, 2001). In HDPE geomembranes, the additives incorporated in the polymer formation may be susceptible to extraction, which would leave the geomembrane unprotected and susceptible to subsequent oxidative degradation (Koerner et al., 2005).
- Temperature – the higher the temperature the more rapid the degradation via the oxidation and chemical mechanisms described above.
- Stress state – typically geomembranes are subjected to vertical compressive stress but actual stress is site-specific. The presence of tensile stresses less than the short-term mechanical strength of the material lead to environmental stress cracking (Koerner et al., 2005). The presence of chemicals may accelerate cracking (Koerner et al., 2005).

1.5 Lifetime Stages of HDPE

Hsuan and Koerner (1998) describe that the oxidative degradation of HDPE geomembrane can be divided into three distinct stages:

- Stage A – Antioxidant depletion time.
- Stage B – Induction Time to the Onset of Degradation.
- Stage C – Time to reach 50% Degradation (Half-life), based on change of the molecular structure accompanied by a deterioration of the decisive mechanical properties.

The duration of the antioxidant depletion stage (Stage A) is dependent on both the type and amount of various antioxidants used in the precise formulation of the HDPE, the service temperature and the nature of the site-specific environment (Rowe and Sangam, 2001). The depletion of anti-oxidants is a consequence of chemical reactions with oxygen diffusing into the geomembrane and the physical loss of anti-oxidants from the geomembrane. The physical loss of anti-oxidants is related to their physical distribution in the geomembrane and their volatility and extractability in the in-situ environment (Koerner et al., 2005).

Once anti-oxidants are depleted, the rate of oxidation follows an S-shaped curve: the initial rate of oxidation is very slow, followed by an accelerated period and then the rate slows again. The initial period of slow oxidation is referred to as induction time or Stage B (Hsuan and Koerner, 1998). During Stage B the polymer reacts with oxygen forming hydroperoxide (ROOH), however the amount of ROOH formed is very small and the compound does not decompose further into other free radicals at this stage. As oxidation continues and ROOH is being formed, the concentration of ROOH will eventually reach a critical level at which ROOH begins to decompose into other free radicals. The presence of additional free radicals causes an increased rate of oxidation, which signifies the end of Stage B.

In Stage C oxidation continues and the polymer begins to degrade with noticeable change in the physical properties, including decreases in both tensile strength and break strain until the material reaches the limit of service life (half-life) (Hsuan and Koerner, 1998).

1.6 Service Life Estimate

Sangam (2001) examined the service lives of HDPE geomembranes under various exposure condition scenarios that the geomembranes may be subjected to when used as bottom liners for MSW landfills. For the typical groundwater temperature range of 7–10°C, Sangam (2001) estimated that the geomembrane used as a secondary liner will last at least 400 years provided that it has a suitable antioxidant package, is not subjected to significant tensile stress and is covered by an adequate protection layer. Koerner, Hsuan and Koerner (2005) used test-derived data and modeling to estimate that the total predicted half-life (Stages A, B and C) of HDPE is between 446 years at 20°C and 69 years at 40°C. The predicated time of Stage C was based on Arrhenius modeling and is dependent on the activation energy.

The average annual surface temperature in Campbell River, BC is 9.0°C and ranges from a daily average of 2.1°C in December to 17.3°C in July (Government of Canada, 2018). Due the nature of the waste, being DLC and not containing significant volumes of putrescible waste, biological activity will not be significant, therefore the temperature on the liner is not expected to be elevated. Based on the preceding, the HDPE geomembrane will be exposed to temperatures below or within the range of 20°C resulting in a service life well beyond the estimated CLS of the Landfill.

2. References

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Appendix C
Soil Acceptance Plan

Northwin Landfill
#210-909 Island Highway
Campbell River, BC
V9W 2C2
Phone (250) 286-1148
Fax (250) 286-3546

Soil Screening Process

Upland staff will complete the following steps prior to the acceptance of soil and during discharge at the Original Landfill lined cell.

Phase 1 – Prior to Discharge

Ask the Company the following questions and confirm their responses by visual inspection.

1. Is the soil generated from a site that may be contaminated? Y/N

2. Does the soil contain or is intermixed with waste including but not limited to plastic, metal debris, PVC pipe, or insulation? Y/N

3. Does the soil have any visible stains? Y/N

4. Is the soil odorous? Y/N

5. Does the soil comply with the OCP Soil Acceptance Plan? Y/N

The generating company must sign the Soil Acceptance Agreement, answered No to Questions 1 to 4, and answered Yes to Question 5, before proceeding with soil discharge to the Original Landfill lined cell.

If the answer to Question 1 is yes, the soil characterization must be certified by Qualified Professional.

Phase 2 – During/Following Discharge

During discharge (i.e., dumping) at the lined cell, confirm that the soil does not contain any waste material including but not limited to:

1. Plastic

2. Metal debris

3. PVC pipe

4. Insulation

5. Asbestos Containing Material

6. Other waste material

7. Staining

8. Odorous soil (i.e., gasoline, chemical, paint; etc. odour)

If the soil contains one or more waste materials, isolate the soil for testing or removal. Record non-compliant or rejected loads on the corresponding Soil Acceptance Agreement and contact your supervisor for further direction.

Northwin Landfill
#210-909 Island Highway
Campbell River, BC
V9W 2C2
Phone (250) 286-1148 Fax (250) 286-3546

Soil Acceptance Agreement

This Agreement must be executed before any soil can be accepted by Upland Excavating Ltd. at the Northwin Landfill located at 7295 Gold River Highway (Northwin Landfill). The Northwin Landfill requires this agreement to be executed by an authorized signatory of your firm (the "Company").

By signing this agreement, the Company represents and warrants to Northwin Landfill that none of the soil delivered to Northwin Landfill by the Company is hazardous waste and does not contain any hazardous waste constituents as defined by the Qualified Professional for the Northwin Landfill (the "Criteria") or any other criteria stipulated by Northwin Landfill and which may be amended from time to time at its sole discretion upon notice to the Company.

Northwin Landfill further serves the right to inspect and sample and/or may require the Company to sample any and all soil before accepting the soil. The right of Northwin Landfill to inspect or sample the soil does not reduce, restrict or otherwise affect the Company's liability in relation to soil that that contains any waste material or does not meet the Criteria. Any soil that contains waste material or does not meet the Criteria may be rejected by Northwin Landfill acting in its discretion and Northwin Landfill may request the Company to remove and dispose of such soil/material, such removal and disposal being the sole cost, risk and responsibility of the Company. If after acceptance by Northwin Landfill, the soil is discovered to include waste material or not meet the Criteria, Northwin Landfill will notify the Company. If requested the Company shall remove the soil/material within 24 hours of notification and dispose of the same in accordance with all applicable laws.

The Company agrees to defend, indemnify and hold Northwin Landfill harmless from and against any and all claims, demands, orders, causes of action, damages, liabilities, losses, expenses, penalties and all costs of defense relative thereto, including legal fees, caused by or resulting from the Company's breach of this agreement, including without limitation, any breach of the Company's obligation to deliver only soil and meets the Criteria.

This Agreement does not confer a right on the Company to deliver soil to the Northwin Landfill. Northwin Landfill reserves the right to reject for any reason, any and all deliveries of soil made by or desired to be made by the Company.

This Agreement commences effective as of the first day on which the Company delivers soil to the Northwin Landfill.

Any waiver of any provisions of this Agreement must be in writing signed by the Northwin Landfill.

Name:	Title:
Company:	Company Address:
Site Name:	Site Address:
Signature:	Date:

Appendix D
Surface Water Management Plan Supporting Documents

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2021/03/26

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CAMPBELL RIVER A BC 1021261
(composite)
Latitude: 49 57'N Longitude: 125 16'W Elevation/Altitude: 108 m

Years/Années : 1970 - 2002 # Years/Années : 21

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Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

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Year / Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1970	-99.9	-99.9	-99.9	-99.9	9.4	16.0	25.7	43.7	55.1
1971	-99.9	-99.9	-99.9	-99.9	9.1	15.5	29.2	46.0	57.7
1972	-99.9	-99.9	-99.9	-99.9	15.5	22.9	38.9	57.9	73.9
1973	-99.9	-99.9	-99.9	-99.9	9.1	14.0	26.2	39.4	53.3
1974	-99.9	-99.9	-99.9	-99.9	8.1	12.4	26.4	39.9	65.5
1975	-99.9	-99.9	-99.9	-99.9	18.3	20.6	41.9	44.2	59.7
1976	-99.9	-99.9	-99.9	-99.9	8.1	15.7	41.1	45.7	48.5
1981	-99.9	-99.9	-99.9	-99.9	12.4	18.6	33.4	39.8	63.2
1982	3.3	5.2	7.8	13.7	17.7	19.6	32.4	49.2	62.9
1983	2.8	3.9	4.7	7.4	10.9	17.7	33.6	53.1	79.6
1984	4.2	5.6	6.9	12.3	20.2	29.6	48.6	59.3	62.0
1985	2.6	2.9	3.6	6.3	9.0	12.0	21.4	24.7	36.8
1986	5.1	5.9	6.1	7.3	7.8	13.9	27.5	40.7	56.1
1987	2.4	3.2	3.7	4.6	8.5	16.4	39.0	43.6	65.7
1988	1.8	2.2	3.0	4.9	8.6	16.9	36.1	45.7	50.5
1989	4.6	7.1	9.0	13.0	14.5	14.6	18.5	29.2	39.2
1990	5.2	7.7	9.6	12.9	15.8	16.2	24.7	45.9	69.8
1991	1.7	2.8	3.9	5.9	9.6	16.9	42.5	64.1	72.3
1992	3.1	4.3	6.1	8.6	11.4	13.6	28.6	-99.9	61.6
1993	2.1	3.6	4.1	6.5	9.3	16.0	36.2	61.9	97.4
1994	3.6	4.8	5.3	6.8	9.7	15.3	31.9	49.6	58.3

1995	7.4	10.4	11.6	12.4	14.1	19.5	34.8	53.6	68.1
1996	5.5	5.9	6.1	8.0	11.5	14.9	27.6	39.9	50.9
1997	4.9	5.8	7.0	9.5	10.9	13.5	35.1	41.6	63.6
1998	5.5	8.8	10.3	13.1	15.3	18.8	32.5	-99.9	61.0
1999	2.2	3.6	4.5	6.0	9.1	17.2	33.2	63.6	81.0
2000	5.5	8.4	10.2	13.1	14.7	14.7	20.2	28.4	37.8
2001	3.5	4.8	5.4	8.9	13.5	18.1	32.3	38.3	46.8
2002	3.9	4.9	6.2	6.9	9.7	13.1	26.1	43.5	55.7
# Yrs. Années	21	21	21	21	29	29	29	27	29
Mean Moyenne	3.9	5.3	6.4	9.0	11.8	16.7	31.9	45.6	60.5
Std. Dev. Écart-type	1.5	2.2	2.5	3.1	3.5	3.6	7.1	10.1	13.2
Skew. Dissymétrie	0.45	0.75	0.62	0.35	0.86	1.84	0.21	0.06	0.50
Kurtosis	3.03	3.42	2.78	1.93	2.98	8.31	3.13	3.19	4.36

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1984	2 h	29.6	27.8

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	3.6	4.9	5.8	7.0	7.8	8.6	21
10 min	5.0	6.9	8.1	9.7	10.9	12.1	21
15 min	6.0	8.2	9.7	11.5	12.9	14.2	21
30 min	8.4	11.2	13.0	15.3	17.0	18.7	21
1 h	11.2	14.3	16.3	18.9	20.8	22.6	29
2 h	16.1	19.3	21.3	24.0	25.9	27.8	29
6 h	30.8	37.0	41.2	46.4	50.3	54.2	29
12 h	44.0	52.9	58.9	66.3	71.9	77.4	27
24 h	58.3	70.0	77.7	87.5	94.7	101.9	29

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	43.2	59.4	70.1	83.6	93.6	103.5	21
	+/- 7.2	+/- 12.1	+/- 16.3	+/- 22.0	+/- 26.3	+/- 30.7	21
10 min	29.8	41.3	48.9	58.4	65.5	72.6	21
	+/- 5.1	+/- 8.6	+/- 11.6	+/- 15.6	+/- 18.7	+/- 21.8	21
15 min	24.1	32.9	38.7	46.0	51.5	56.9	21
	+/- 3.9	+/- 6.6	+/- 8.9	+/- 12.0	+/- 14.3	+/- 16.7	21
30 min	16.9	22.4	26.0	30.6	34.1	37.4	21
	+/- 2.4	+/- 4.1	+/- 5.6	+/- 7.5	+/- 9.0	+/- 10.4	21
1 h	11.2	14.3	16.3	18.9	20.8	22.6	29
	+/- 1.2	+/- 1.9	+/- 2.6	+/- 3.5	+/- 4.2	+/- 4.9	29
2 h	8.1	9.6	10.7	12.0	13.0	13.9	29
	+/- 0.6	+/- 1.0	+/- 1.4	+/- 1.8	+/- 2.2	+/- 2.5	29
6 h	5.1	6.2	6.9	7.7	8.4	9.0	29
	+/- 0.4	+/- 0.7	+/- 0.9	+/- 1.2	+/- 1.4	+/- 1.7	29
12 h	3.7	4.4	4.9	5.5	6.0	6.5	27
	+/- 0.3	+/- 0.5	+/- 0.7	+/- 0.9	+/- 1.1	+/- 1.2	27
24 h	2.4	2.9	3.2	3.6	3.9	4.2	29
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.6	+/- 0.7	+/- 0.8	29

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	16.1	21.5	25.1	29.6	33.0	36.3
Std. Dev. /Écart-type (RR)	13.9	19.4	23.1	27.8	31.2	34.7
Std. Error/Erreur-type	0.7	1.1	1.4	1.7	2.0	2.3
Coefficient (A)	12.0	15.5	17.7	20.6	22.7	24.7
Exponent/Exposant (B)	-0.499	-0.529	-0.543	-0.556	-0.563	-0.569
Mean % Error/% erreur moyenne	3.3	4.2	4.9	5.5	5.8	6.1

Design Calculations - Forebay Desgin
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbiaa

Task: Design forebay for the inlet of Infiltration Pond

In accordance with "Best Management Practices Guide for Stormwater", Sedimentation forebay should provide 10% volume of total design storage volume for pond.

Infiltration Basin Volume=	3313	m^3
Sediment Forebay Volume=	10% of Infiltration Basin Volume	
Sediment Forebay Volume=	331	m^3
Forebay Length to width ratio=	2:1	
Forebay Depth=	1	m
Forebay Length=	**26**	m
Forebay Width=	**13**	m
Forebay Depth=	**1**	m

Reference: Allan Gibb, Harlan Kelly, and Thomas Schueler, 1999, Best Management Practices Guide for Stormwater, Prepared for Greater Vancouver Sewerage and Drainage District.

Design Calculations - Infiltration Pond
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

East and West Infiltration Pond
Stage/Storage Relationship

Elevation		Area		Depth		Total Storage	
(m)	(ft)	(m^2)	(ft^2)	(m)	(ft)	(m^3)	(ft^3)
150	492.1	2930	31533	0			
150.20	492.8	3078	33128	0.2	0.7	601	21214
150.40	493.4	3228	34751	0.4	1.3	1232	43493
150.60	494.1	3382	36401	0.6	2.0	1893	66864
150.80	494.8	3538	38080	0.8	2.6	2587	91356
151.00	495.4	3696	39787	1	3.3	3313	116994

Note:

* Volume for an interval calculated by Average End Area Method.
* Length to width ratio of infiltration pond assumed as 3:1.
* Assume vertical to horizontal slope of 1:3 on all sides of infiltration pond
*Area calculated for 1m depth assumes 10% goes into sedimentation bay so uses 0.9 fac

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	5yr_SCS_Type_IA_80.6mm	J5
102	0.08	21.05	0.00	45.0000	5yr_SCS_Type_IA_80.6mm	J5
103	0.13	33.30	0.00	45.0000	5yr_SCS_Type_IA_80.6mm	J4
104	1.35	245.89	0.00	35.0000	5yr_SCS_Type_IA_80.6mm	J8
105	0.20	67.73	0.00	20.0000	5yr_SCS_Type_IA_80.6mm	J7
106	0.95	146.54	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J2
107	0.51	146.63	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J5
108	0.53	150.14	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J8
109	0.92	141.63	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J3
110	0.18	40.56	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J1
111	0.19	42.33	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J1
112	0.46	185.00	100.00	15.0000	5yr_SCS_Type_IA_80.6mm	POND_East
113	0.29	82.37	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J9
114	0.50	200.56	100.00	15.0000	5yr_SCS_Type_IA_80.6mm	POND_West
115	0.28	81.14	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.595	80.600
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.446
Surface Runoff	0.539	73.029
Final Storage	0.001	0.124

Continuity Error (%) 0.000

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.539	5.390
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.560	5.600
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-3.899	

Highest Continuity Errors

Node POND_West (-4.00%)
Node POND_East (-3.80%)

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link OL1 (4)
Link OL2 (3)

Routing Time Step Summary

Minimum Time Step	:	0.50 sec
Average Time Step	:	1.00 sec
Maximum Time Step	:	1.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	80.60	0.00	0.00	7.91	72.69	0.57	0.03	0.902
102	80.60	0.00	0.00	7.91	72.69	0.06	0.00	0.902
103	80.60	0.00	0.00	7.91	72.69	0.10	0.00	0.902
104	80.60	0.00	0.00	7.94	72.66	0.98	0.05	0.902
105	80.60	0.00	0.00	7.92	72.68	0.15	0.01	0.902
106	80.60	0.00	0.00	9.05	71.55	0.68	0.03	0.888

107	80.60	0.00	0.00	8.92	71.68	0.37	0.02
0.889							
108	80.60	0.00	0.00	8.92	71.68	0.38	0.02
0.889							
109	80.60	0.00	0.00	9.05	71.55	0.66	0.03
0.888							
110	80.60	0.00	0.00	8.98	71.62	0.13	0.01
0.889							
111	80.60	0.00	0.00	8.98	71.62	0.14	0.01
0.889							
112	80.60	0.00	0.00	0.00	79.65	0.37	0.02
0.988							
113	80.60	0.00	0.00	8.92	71.68	0.21	0.01
0.889							
114	80.60	0.00	0.00	0.00	79.65	0.40	0.02
0.988							
115	80.60	0.00	0.00	8.92	71.68	0.20	0.01
0.889							

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.14	164.64	0 08:00	0.04
J10	JUNCTION	0.00	0.10	164.60	0 08:01	0.03
J2	JUNCTION	0.04	0.33	164.63	0 08:00	0.10
J3	JUNCTION	0.03	0.30	164.60	0 08:00	0.09
J4	JUNCTION	0.00	0.04	164.04	0 08:00	0.01
J5	JUNCTION	0.01	0.13	156.13	0 08:00	0.04
J6	JUNCTION	0.01	0.10	153.10	0 08:00	0.03
J7	JUNCTION	0.00	0.04	164.04	0 08:00	0.01
J8	JUNCTION	0.01	0.14	156.14	0 08:00	0.04
J9	JUNCTION	0.01	0.10	153.10	0 08:00	0.03
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.01	0.14	150.14	0 09:41	0.04
POND_West	STORAGE	0.00	0.13	150.13	0 09:36	0.04

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.013	0.013	0 08:00	0.267	0.267	-0.084
J10	JUNCTION	0.000	0.001	0 07:15	0	0.00178	1.356
J2	JUNCTION	0.033	0.046	0 08:00	0.681	0.949	0.030
J3	JUNCTION	0.032	0.032	0 08:00	0.659	0.66	0.010
J4	JUNCTION	0.005	0.050	0 08:00	0.0968	1.05	-0.004
J5	JUNCTION	0.048	0.098	0 08:00	1	2.05	-0.003
J6	JUNCTION	0.010	0.108	0 08:00	0.204	2.25	0.002
J7	JUNCTION	0.007	0.038	0 08:00	0.148	0.806	-0.009
J8	JUNCTION	0.065	0.104	0 08:00	1.36	2.17	-0.004
J9	JUNCTION	0.010	0.114	0 08:00	0.207	2.37	0.003
OF1	OUTFALL	0.000	0.049	0 04:11	0	2.76	0.000
OF2	OUTFALL	0.000	0.049	0 04:08	0	2.84	0.000
POND_East	STORAGE	0.016	0.130	0 08:00	0.368	2.74	-3.665
POND_West	STORAGE	0.018	0.126	0 08:00	0.399	2.65	-3.842

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.016	0	0	0	0.404	12	0 09:41	0.049
POND_West	0.014	0	0	0	0.375	11	0 09:36	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	14.78	0.036	0.049	2.755
OF2	14.94	0.037	0.049	2.845
System	14.86	0.073	0.098	5.600

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.013	0 08:00	0.10	0.01	0.40
D102	CONDUIT	0.046	0 08:00	0.42	0.06	0.32
D103	CONDUIT	0.050	0 08:00	0.75	0.01	0.18
D104	CONDUIT	0.098	0 08:00	0.96	0.05	0.24
D105	CONDUIT	0.001	0 07:15	0.01	0.00	0.33
D106	CONDUIT	0.031	0 08:00	0.38	0.05	0.28
D107	CONDUIT	0.038	0 08:00	0.57	0.01	0.18
D108	CONDUIT	0.104	0 08:00	0.99	0.06	0.24
D109	CONDUIT	0.108	0 08:00	1.27	0.04	0.21
D110	CONDUIT	0.114	0 08:00	1.39	0.03	0.20
OL1	DUMMY	0.049	0 04:11			
OL2	DUMMY	0.049	0 04:08			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.02	0.01	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.37	0.00
D104	1.00	0.48	0.00	0.00	0.50	0.02	0.00	0.00	0.08	0.00
D105	1.00	0.02	0.02	0.00	0.96	0.00	0.00	0.00	0.93	0.00
D106	1.00	0.02	0.01	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.38	0.00

D108	1.00	0.48	0.00	0.00	0.49	0.03	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:51:36 2021
Analysis ended on: Mon Jun 28 15:51:43 2021
Total elapsed time: 00:00:07

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	10yr_SCS_Type_IA_89.5mm	J5
102	0.08	21.05	0.00	45.0000	10yr_SCS_Type_IA_89.5mm	J5
103	0.13	33.30	0.00	45.0000	10yr_SCS_Type_IA_89.5mm	J4
104	1.35	245.89	0.00	35.0000	10yr_SCS_Type_IA_89.5mm	J8
105	0.20	67.73	0.00	20.0000	10yr_SCS_Type_IA_89.5mm	J7
106	0.95	146.54	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J2
107	0.51	146.63	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J5
108	0.53	150.14	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J8
109	0.92	141.63	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J3
110	0.18	40.56	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J1
111	0.19	42.33	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J1
112	0.46	185.00	100.00	15.0000	10yr_SCS_Type_IA_89.5mm	POND_East
113	0.29	82.37	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J9
114	0.50	200.56	100.00	15.0000	10yr_SCS_Type_IA_89.5mm	POND_West
115	0.28	81.14	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.661	89.503
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.454
Surface Runoff	0.605	81.924
Final Storage	0.001	0.124

Continuity Error (%) 0.000

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.605	6.047
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.613	6.131
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-1.395	

Highest Continuity Errors

Node POND_East (-1.53%)
Node POND_West (-1.25%)

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link OL1 (4)
Link OL2 (3)

Routing Time Step Summary

Minimum Time Step	:	0.50 sec
Average Time Step	:	1.00 sec
Maximum Time Step	:	1.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	89.50	0.00	0.00	7.92	81.58	0.64	0.03	0.912
102	89.50	0.00	0.00	7.92	81.58	0.07	0.00	0.912
103	89.50	0.00	0.00	7.92	81.58	0.11	0.01	0.912
104	89.50	0.00	0.00	7.95	81.55	1.10	0.05	0.911
105	89.50	0.00	0.00	7.93	81.58	0.17	0.01	0.911
106	89.50	0.00	0.00	9.06	80.44	0.77	0.04	0.899

107	89.50	0.00	0.00	8.92	80.58	0.41	0.02
0.900							
108	89.50	0.00	0.00	8.92	80.58	0.42	0.02
0.900							
109	89.50	0.00	0.00	9.06	80.44	0.74	0.04
0.899							
110	89.50	0.00	0.00	8.99	80.51	0.15	0.01
0.900							
111	89.50	0.00	0.00	8.99	80.51	0.15	0.01
0.900							
112	89.50	0.00	0.00	0.00	88.55	0.41	0.02
0.989							
113	89.50	0.00	0.00	8.92	80.58	0.23	0.01
0.900							
114	89.50	0.00	0.00	0.00	88.55	0.44	0.02
0.989							
115	89.50	0.00	0.00	8.92	80.58	0.23	0.01
0.900							

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.15	164.65	0 08:00	0.05
J10	JUNCTION	0.00	0.11	164.61	0 08:01	0.03
J2	JUNCTION	0.04	0.35	164.65	0 08:00	0.11
J3	JUNCTION	0.03	0.31	164.61	0 08:00	0.09
J4	JUNCTION	0.00	0.05	164.05	0 08:00	0.01
J5	JUNCTION	0.01	0.14	156.14	0 08:00	0.04
J6	JUNCTION	0.01	0.11	153.11	0 08:00	0.03
J7	JUNCTION	0.00	0.04	164.04	0 08:00	0.01
J8	JUNCTION	0.01	0.15	156.15	0 08:00	0.05
J9	JUNCTION	0.01	0.11	153.11	0 08:00	0.03
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.01	0.17	150.17	0 10:02	0.05
POND_West	STORAGE	0.01	0.16	150.16	0 09:58	0.05

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.014	0.014	0 08:00	0.3	0.3	-0.078
J10	JUNCTION	0.000	0.001	0 07:15	0	0.00208	1.072
J2	JUNCTION	0.037	0.051	0 08:00	0.766	1.07	0.028
J3	JUNCTION	0.035	0.035	0 08:00	0.741	0.743	0.011
J4	JUNCTION	0.005	0.056	0 08:00	0.109	1.18	-0.004
J5	JUNCTION	0.054	0.109	0 08:00	1.12	2.3	-0.003
J6	JUNCTION	0.011	0.120	0 08:00	0.229	2.53	0.002
J7	JUNCTION	0.008	0.043	0 08:00	0.166	0.906	-0.009
J8	JUNCTION	0.073	0.115	0 08:00	1.53	2.43	-0.004
J9	JUNCTION	0.011	0.127	0 08:00	0.232	2.67	0.003
OF1	OUTFALL	0.000	0.049	0 04:01	0	3.01	0.000
OF2	OUTFALL	0.000	0.049	0 03:56	0	3.12	0.000
POND_East	STORAGE	0.018	0.144	0 08:00	0.41	3.07	-1.510
POND_West	STORAGE	0.020	0.140	0 08:00	0.444	2.97	-1.236

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.026	1	0	0	0.520	16	0 10:02	0.049
POND_West	0.022	1	0	0	0.481	15	0 09:58	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	15.03	0.039	0.049	3.009
OF2	15.32	0.039	0.049	3.122
System	15.18	0.078	0.098	6.131

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.014	0 08:00	0.10	0.02	0.42
D102	CONDUIT	0.051	0 08:00	0.44	0.07	0.33
D103	CONDUIT	0.056	0 08:00	0.78	0.01	0.19
D104	CONDUIT	0.109	0 08:00	0.99	0.06	0.25
D105	CONDUIT	0.001	0 07:15	0.01	0.00	0.34
D106	CONDUIT	0.035	0 08:00	0.39	0.05	0.29
D107	CONDUIT	0.043	0 08:00	0.59	0.01	0.19
D108	CONDUIT	0.115	0 08:00	1.02	0.06	0.26
D109	CONDUIT	0.120	0 08:00	1.31	0.04	0.22
D110	CONDUIT	0.126	0 08:00	1.43	0.04	0.21
OL1	DUMMY	0.049	0 04:01			
OL2	DUMMY	0.049	0 03:56			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.37	0.00
D104	1.00	0.48	0.00	0.00	0.50	0.02	0.00	0.00	0.08	0.00
D105	1.00	0.02	0.02	0.00	0.97	0.00	0.00	0.00	0.93	0.00
D106	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.38	0.00

D108	1.00	0.48	0.00	0.00	0.49	0.04	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:50:23 2021
Analysis ended on: Mon Jun 28 15:50:30 2021
Total elapsed time: 00:00:07

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	100yr_SCS_Type_IA_117.4mm	J5
102	0.08	21.05	0.00	45.0000	100yr_SCS_Type_IA_117.4mm	J5
103	0.13	33.30	0.00	45.0000	100yr_SCS_Type_IA_117.4mm	J4
104	1.35	245.89	0.00	35.0000	100yr_SCS_Type_IA_117.4mm	J8
105	0.20	67.73	0.00	20.0000	100yr_SCS_Type_IA_117.4mm	J7
106	0.95	146.54	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J2
107	0.51	146.63	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J5
108	0.53	150.14	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J8
109	0.92	141.63	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J3
110	0.18	40.56	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J1
111	0.19	42.33	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J1
112	0.46	185.00	100.00	15.0000	100yr_SCS_Type_IA_117.4mm	POND_East
113	0.29	82.37	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J9
114	0.50	200.56	100.00	15.0000	100yr_SCS_Type_IA_117.4mm	POND_West
115	0.28	81.14	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.867	117.399
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.470
Surface Runoff	0.810	109.804
Final Storage	0.001	0.124

Continuity Error (%) 0.000

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.810	8.105
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.811	8.115
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.129	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link OL1 (1)
Link OL2 (1)

Routing Time Step Summary

Minimum Time Step	:	0.50 sec
Average Time Step	:	1.00 sec
Maximum Time Step	:	1.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	117.40	0.00	0.00	7.94	109.46	0.86	0.04	0.932
102	117.40	0.00	0.00	7.94	109.46	0.09	0.00	0.932
103	117.40	0.00	0.00	7.94	109.46	0.15	0.01	0.932
104	117.40	0.00	0.00	7.97	109.42	1.48	0.07	0.932
105	117.40	0.00	0.00	7.95	109.45	0.22	0.01	0.932
106	117.40	0.00	0.00	9.08	108.32	1.03	0.05	0.923
107	117.40	0.00	0.00	8.94	108.46	0.56	0.03	0.924
108	117.40	0.00	0.00	8.94	108.46	0.57	0.03	0.924
109	117.40	0.00	0.00	9.08	108.32	1.00	0.05	0.923

110	117.40	0.00	0.00	9.00	108.39	0.20	0.01
0.923							
111	117.40	0.00	0.00	9.00	108.39	0.21	0.01
0.923							
112	117.40	0.00	0.00	0.00	116.45	0.54	0.02
0.992							
113	117.40	0.00	0.00	8.94	108.46	0.31	0.01
0.924							
114	117.40	0.00	0.00	0.00	116.45	0.58	0.03
0.992							
115	117.40	0.00	0.00	8.94	108.46	0.31	0.01
0.924							

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.18	164.68	0 08:00	0.06
J10	JUNCTION	0.00	0.14	164.64	0 08:00	0.04
J2	JUNCTION	0.04	0.38	164.68	0 08:00	0.12
J3	JUNCTION	0.04	0.34	164.64	0 08:00	0.10
J4	JUNCTION	0.00	0.05	164.05	0 08:00	0.02
J5	JUNCTION	0.01	0.16	156.16	0 08:00	0.05
J6	JUNCTION	0.01	0.13	153.13	0 08:00	0.04
J7	JUNCTION	0.00	0.05	164.05	0 08:00	0.01
J8	JUNCTION	0.01	0.17	156.17	0 08:00	0.05
J9	JUNCTION	0.01	0.12	153.12	0 08:00	0.04
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.03	0.32	150.32	0 11:45	0.10
POND_West	STORAGE	0.03	0.30	150.30	0 11:34	0.09

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.019	0.019	0 08:00	0.404	0.404	-0.066
J10	JUNCTION	0.000	0.001	0 07:14	0	0.00299	0.689
J2	JUNCTION	0.048	0.067	0 08:00	1.03	1.44	0.024
J3	JUNCTION	0.047	0.047	0 08:00	0.997	1	0.011
J4	JUNCTION	0.007	0.074	0 08:00	0.146	1.58	-0.004
J5	JUNCTION	0.070	0.144	0 08:00	1.51	3.09	-0.003
J6	JUNCTION	0.014	0.159	0 08:00	0.308	3.4	0.002
J7	JUNCTION	0.010	0.057	0 08:00	0.222	1.22	-0.008
J8	JUNCTION	0.095	0.152	0 08:00	2.05	3.27	-0.003
J9	JUNCTION	0.015	0.167	0 08:00	0.313	3.58	0.002
OF1	OUTFALL	0.000	0.049	0 02:50	0	3.99	0.000
OF2	OUTFALL	0.000	0.049	0 02:37	0	4.12	0.000
POND_East	STORAGE	0.024	0.190	0 08:00	0.539	4.12	-0.076
POND_West	STORAGE	0.026	0.184	0 08:00	0.584	3.98	-0.184

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.089	3	0	0	0.975	29	0 11:45	0.049
POND_West	0.077	2	0	0	0.902	27	0 11:34	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	16.47	0.047	0.049	3.991
OF2	16.96	0.047	0.049	4.124
System	16.71	0.094	0.098	8.115

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.019	0 08:00	0.11	0.02	0.47
D102	CONDUIT	0.067	0 08:00	0.48	0.10	0.36
D103	CONDUIT	0.074	0 08:00	0.84	0.01	0.22
D104	CONDUIT	0.144	0 08:00	1.06	0.08	0.29
D105	CONDUIT	0.001	0 07:14	0.01	0.00	0.39
D106	CONDUIT	0.046	0 08:00	0.42	0.07	0.32
D107	CONDUIT	0.057	0 08:00	0.64	0.01	0.22
D108	CONDUIT	0.152	0 08:00	1.10	0.08	0.29
D109	CONDUIT	0.158	0 08:00	1.41	0.05	0.25
D110	CONDUIT	0.167	0 08:00	1.54	0.05	0.25
OL1	DUMMY	0.049	0 02:50			
OL2	DUMMY	0.049	0 02:37			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.47	0.21	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D104	1.00	0.47	0.00	0.00	0.50	0.03	0.00	0.00	0.08	0.00
D105	1.00	0.02	0.01	0.00	0.97	0.00	0.00	0.00	0.91	0.00
D106	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.47	0.21	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D108	1.00	0.47	0.00	0.00	0.46	0.07	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

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Conduit Surcharge Summary
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No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:49:00 2021
Analysis ended on: Mon Jun 28 15:49:06 2021
Total elapsed time: 00:00:06

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
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Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	200yr_SCS_Type_IA_126.8mm	J5
102	0.08	21.05	0.00	45.0000	200yr_SCS_Type_IA_126.8mm	J5
103	0.13	33.30	0.00	45.0000	200yr_SCS_Type_IA_126.8mm	J4
104	1.35	245.89	0.00	35.0000	200yr_SCS_Type_IA_126.8mm	J8
105	0.20	67.73	0.00	20.0000	200yr_SCS_Type_IA_126.8mm	J7
106	0.95	146.54	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J2
107	0.51	146.63	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J5
108	0.53	150.14	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J8
109	0.92	141.63	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J3
110	0.18	40.56	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J1
111	0.19	42.33	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J1
112	0.46	185.00	100.00	15.0000	200yr_SCS_Type_IA_126.8mm	POND_East
113	0.29	82.37	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J9
114	0.50	200.56	100.00	15.0000	200yr_SCS_Type_IA_126.8mm	POND_West
115	0.28	81.14	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.936	126.800
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.474
Surface Runoff	0.880	119.202
Final Storage	0.001	0.124

Continuity Error (%) 0.000

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.880	8.798
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.880	8.802
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.040	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link OL2 (1)
Link OL1 (1)

Routing Time Step Summary

Minimum Time Step	:	0.50 sec
Average Time Step	:	1.00 sec
Maximum Time Step	:	1.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	126.80	0.00	0.00	7.95	118.85	0.94	0.04	0.937
102	126.80	0.00	0.00	7.95	118.85	0.10	0.00	0.937
103	126.80	0.00	0.00	7.95	118.85	0.16	0.01	0.937
104	126.80	0.00	0.00	7.98	118.82	1.61	0.07	0.937
105	126.80	0.00	0.00	7.95	118.85	0.24	0.01	0.937
106	126.80	0.00	0.00	9.08	117.72	1.12	0.05	0.928
107	126.80	0.00	0.00	8.94	117.86	0.60	0.03	0.929
108	126.80	0.00	0.00	8.94	117.86	0.62	0.03	0.929
109	126.80	0.00	0.00	9.08	117.72	1.08	0.05	0.928

110	126.80	0.00	0.00	9.01	117.79	0.21	0.01
0.929							
111	126.80	0.00	0.00	9.01	117.79	0.22	0.01
0.929							
112	126.80	0.00	0.00	0.00	125.85	0.58	0.03
0.992							
113	126.80	0.00	0.00	8.94	117.86	0.34	0.02
0.929							
114	126.80	0.00	0.00	0.00	125.85	0.63	0.03
0.992							
115	126.80	0.00	0.00	8.94	117.86	0.33	0.02
0.929							

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.19	164.69	0 08:00	0.06
J10	JUNCTION	0.00	0.14	164.64	0 08:00	0.04
J2	JUNCTION	0.04	0.39	164.69	0 08:00	0.12
J3	JUNCTION	0.04	0.34	164.64	0 08:00	0.10
J4	JUNCTION	0.00	0.06	164.06	0 08:00	0.02
J5	JUNCTION	0.01	0.17	156.17	0 08:00	0.05
J6	JUNCTION	0.01	0.13	153.13	0 08:00	0.04
J7	JUNCTION	0.00	0.05	164.05	0 08:00	0.02
J8	JUNCTION	0.01	0.18	156.18	0 08:00	0.05
J9	JUNCTION	0.01	0.13	153.13	0 08:00	0.04
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.04	0.38	150.38	0 12:32	0.12
POND_West	STORAGE	0.04	0.35	150.35	0 11:53	0.11

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.021	0.021	0 08:00	0.439	0.439	-0.063
J10	JUNCTION	0.000	0.002	0 07:14	0	0.00328	0.652
J2	JUNCTION	0.052	0.073	0 08:00	1.12	1.56	0.023
J3	JUNCTION	0.051	0.051	0 08:00	1.08	1.09	0.010
J4	JUNCTION	0.007	0.080	0 08:00	0.158	1.72	-0.004
J5	JUNCTION	0.076	0.156	0 08:00	1.64	3.36	-0.003
J6	JUNCTION	0.016	0.171	0 08:00	0.335	3.69	0.002
J7	JUNCTION	0.011	0.061	0 08:00	0.241	1.33	-0.008
J8	JUNCTION	0.103	0.164	0 08:00	2.23	3.55	-0.003
J9	JUNCTION	0.016	0.180	0 08:00	0.34	3.89	0.002
OF1	OUTFALL	0.000	0.049	0 02:37	0	4.33	0.000
OF2	OUTFALL	0.000	0.049	0 02:23	0	4.47	0.000
POND_East	STORAGE	0.026	0.206	0 08:00	0.582	4.47	-0.005
POND_West	STORAGE	0.028	0.199	0 08:00	0.631	4.32	-0.076

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.122	4	0	0	1.164	35	0 12:32	0.049
POND_West	0.107	3	0	0	1.082	33	0 11:53	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	17.72	0.047	0.049	4.328
OF2	18.27	0.047	0.049	4.473
System	18.00	0.094	0.098	8.802

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.020	0 08:00	0.11	0.02	0.48
D102	CONDUIT	0.073	0 08:00	0.49	0.10	0.37
D103	CONDUIT	0.080	0 08:00	0.86	0.01	0.23
D104	CONDUIT	0.156	0 08:00	1.09	0.08	0.30
D105	CONDUIT	0.002	0 07:14	0.02	0.00	0.41
D106	CONDUIT	0.050	0 08:00	0.43	0.07	0.33
D107	CONDUIT	0.061	0 08:00	0.66	0.01	0.23
D108	CONDUIT	0.164	0 08:00	1.13	0.09	0.31
D109	CONDUIT	0.171	0 08:00	1.44	0.06	0.26
D110	CONDUIT	0.180	0 08:00	1.58	0.05	0.26
OL1	DUMMY	0.049	0 02:37			
OL2	DUMMY	0.049	0 02:23			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.48	0.20	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D104	1.00	0.48	0.00	0.00	0.49	0.03	0.00	0.00	0.08	0.00
D105	1.00	0.01	0.01	0.00	0.98	0.00	0.00	0.00	0.90	0.00
D106	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.48	0.20	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D108	1.00	0.48	0.00	0.00	0.44	0.09	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****

Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:24:09 2021
Analysis ended on: Mon Jun 28 15:24:15 2021
Total elapsed time: 00:00:06

Appendix E
Leachate Generation HELP Model Outputs

Appendix E - Leachate Generation HELP Model Input Parameters

Description of Cover System	Layer Type	Layer Decription
Daily Cover		
	Vegetative Coverage	Bare (Leaf Area Index 0)
	Evaporative Zone Depth	100 mm
	Slope	10 % slope
Sand-Daily Cover	Vertical Percolation Layer	100 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Sand-Daily Cover	Barrier Soil	50 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Municipal Waste	Vertical Percolation Layer	24 m of Municipal Solid Waste (Soil Texture No. 18), Hyd.Cond. $1x10^{-3}$cm/sec
Geotextile	Flexible Membrane Liner	Drainage Net (model default, Soil Texture No. 20), Hyd.Cond. 10cm/sec
		Good placement quality, 2 pinholes/hectare, 6 installation defects/hectare
Drain Rock	Lateral Drainage Layer	300 mm of Gravel (Soil Texture No. 21), Hyd.Cond. $3x10^{-1}$cm/sec
Intermediate Cover		
	Vegetative Coverage	Bare (Leaf Area Index 1)
	Evaporative Zone Depth	250 mm
	Slope	10 % slope
Sand-Intermediate Cover	Vertical Percolation Layer	300 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Sand-Intermediate Cover	Barrier Soil	50 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Municipal Waste	Vertical Percolation Layer	24 m of Municipal Solid Waste (Soil Texture No. 18), Hyd.Cond. $1x10^{-3}$cm/sec
Geotextile	Flexible Membrane Liner	Drainage Net (model default, Soil Texture No. 20), Hyd.Cond. 10cm/sec
		Good placement quality, 2 pinholes/hectare, 6 installation defects/hectare
Drain Rock	Lateral Drainage Layer	300 mm of Gravel (Soil Texture No. 21), Hyd.Cond. $3x10^{-1}$cm/sec
Final Cover		
	Vegetative Coverage	Good stand of grass
	Evaporative Zone Depth	300 mm
	Slope	10%
Topsoil	Vertical Percolation Layer	150 mm of Loamy Sand 9Soil Texture No. 4), Hyd.Cond. $1.7x10^{-3}$cm/sec
Sand	Lateral Drainage Layer	600 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Geosynthetic Clay Liner	Barrier Soil Liner	Bentonite Mat (model default, Soil Texture No. 17), Hyd.Con. $3x10^{-9}$cm/sec
Sand	Vertical Percolation Layer	150 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Municipal Waste	Vertical Percolation Layer	24 m of Municipal Solid Waste (Soil Texture No. 18), Hyd.Cond. $1x10^{-3}$cm/sec
Geotextile	Flexible Membrane Liner	Drainage Net (model default, Soil Texture No. 20), Hyd.Cond. 10cm/sec
		Good placement quality, 2 pinholes/hectare, 6 installation defects/hectare
Drain Rock	Lateral Drainage Layer	300 mm of Gravel (Soil Texture No. 21), Hyd.Cond. $3x10^{-1}$cm/sec

Daily Cover

	Lateral Drainage Collected from Layer 5	Run-off	
Jan	65.1089	34.035	
Feb	84.2772	26.786	
Mar	102.4533	5.216	
Apr	123.0865	0.55	
May	138.0491	0.336	
Jun	123.4093	0.253	
Jul	117.0968	0.335	
Aug	106.9451	0.489	
Sep	86.7352	0.129	
Oct	60.5727	6.234	
Nov	43.3287	11.463	
Dec	50.4224	20.108	
Sum:	1101.4852	105.934	1207.419

```
LATERAL DRAINAGE COLLECTED FROM LAYER  5
   ----------------------------------------
     TOTALS                65.1089  84.2772 102.4533 123.0865 138.04
                          117.0968 106.9451  86.7352  60.5727  43.32

     STD. DEVIATIONS       24.4978  28.8200  30.3134  31.9586  29.09
                           18.4311  17.3214  15.8749  16.8588  14.97

RUNOFF
   ------
     TOTALS                34.035   26.786    5.216    0.550    0.33
                            0.335    0.489    0.129    6.234   11.46

     STD. DEVIATIONS       67.175   67.695   13.713    1.344    1.12
                            1.002    2.820    0.565    7.952   13.01
```

Intermediate Cover

	Lateral Drainage from Layer 5
Jan	54.2613
Feb	73.35
Mar	92.706
Apr	117.4078
May	139.5856
Jun	122.926
Jul	112.8487
Aug	101.057
Sep	82.7143
Oct	54.8109
Nov	32.8243
Dec	39.5423
Sum:	1024.0342

```
   LATERAL DRAINAGE COLLECTED FROM LAYER  5
   ----------------------------------------
     TOTALS                54.2613  73.3592  92.7060 117.4078 139.58
                          112.8487 101.0570  82.7143  54.8109  32.82

     STD. DEVIATIONS       23.4180  26.8001  29.4715  31.4007  28.07
                           20.3881  21.6544  19.3005  17.9345  12.51
```

Final Cover

Jan	2.9168
Feb	2.6859
Mar	2.386
Apr	1.9599
May	1.4829
Jun	0.9079
Jul	0.6186
Aug	0.431
Sep	0.2893
Oct	0.1173
Nov	0.1984
Dec	1.808
Sum:	15.802

```
   LATERAL DRAINAGE COLLECTED FROM LAYER  7
   ----------------------------------------
     TOTALS                 2.9168   2.6859   2.3986   1.9599   1.48
                            0.6186   0.4310   0.2893   0.1173   0.19

     STD. DEVIATIONS        0.8955   0.8772   0.8500   0.5565   0.35
                            0.1340   0.1000   0.0949   0.0888   0.29
```

```
**********************************************************************
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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:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DF8.D10
OUTPUT DATA FILE:           C:\HELP3\88877df8.OUT


TIME:  13:23     DATE:   5/28/2020


**********************************************************************

     TITLE:  Upland Landfill - Daily Cover HDPE Failure C&D

**********************************************************************


     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   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
```

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	2400.00	CM
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0838	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL

FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1597	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	209.980	CM
TOTAL INITIAL WATER	=	209.980	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	

START OF GROWING SEASON (JULIAN DATE) = 91
END OF GROWING SEASON (JULIAN DATE) = 305
EVAPORATIVE ZONE DEPTH = 10.0 CM
AVERAGE ANNUAL WIND SPEED = 8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53

	28.36	30.28	30.04	68.74	74.24	69.47

RUNOFF

TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118

EVAPOTRANSPIRATION

TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	180.9979	156.5872	156.9727	111.9285	40.3257	26.9729
	21.2218	18.5651	29.2020	73.4767	126.3587	168.5397
STD. DEVIATIONS	63.5396	64.1078	51.8090	49.4760	27.7111	19.9570
	21.7540	16.4440	20.3996	26.8081	40.0389	46.5411

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	176.9316	162.1197	157.4841	122.2302	50.5715	26.9056
	22.3385	18.8743	26.5993	59.9102	117.0397	162.0860
STD. DEVIATIONS	55.2198	60.7850	53.8837	46.7045	31.7294	18.2236
	18.9747	16.8879	18.4590	22.3651	35.4900	42.5217

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	1.2600	1.1540	1.1304	0.8927	0.4175	0.2560
	0.2259	0.1974	0.2513	0.4793	0.8581	1.1611
STD. DEVIATIONS	0.3681	0.4049	0.3593	0.3114	0.2116	0.1233
	0.1304	0.1212	0.1277	0.1497	0.2366	0.2834

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.7718	0.7304	0.6655	0.4914	0.1730	0.1189
	0.0908	0.0794	0.1289	0.3097	0.5510	0.7141
STD. DEVIATIONS	0.2726	0.3011	0.2218	0.2170	0.1180	0.0872
	0.0927	0.0705	0.0897	0.1133	0.1775	0.2009

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	8.8090	8.8574	7.8410	6.2886	2.5179	1.3843
	1.1122	0.9397	1.3685	2.9829	6.0216	8.0699
STD. DEVIATIONS	2.7489	3.3251	2.6828	2.4029	1.5798	0.9376
	0.9447	0.8408	0.9497	1.1135	1.8259	2.1166

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1111.14868	(193.93793)	11111.486	74.77763
AVERAGE HEAD ON TOP OF LAYER 4	4.021	(0.714)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1103.09058	(192.71375)	11030.906	74.23534
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.28386	(1.28800)	82.839	0.55748

AVERAGE HEAD ON TOP OF LAYER 6	46.827	(8.247)		
CHANGE IN WATER STORAGE	-2.586	(4.3345)	-25.86	-0.174

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	19.712858	197.12859
AVERAGE HEAD ON TOP OF LAYER 4	26.039	
DRAINAGE COLLECTED FROM LAYER 5	14.79354	147.93542
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.099692	0.99692
AVERAGE HEAD ON TOP OF LAYER 6	224.771	
MAXIMUM HEAD ON TOP OF LAYER 6	286.035	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	29.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	175.2000	0.0730
4	0.0000	0.0000
5	2.5355	0.0845
6	0.4500	0.7500
SNOW WATER	0.000	

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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:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DF7.D10
OUTPUT DATA FILE:           C:\HELP3\88877df7.OUT


TIME:  15:58     DATE:   5/26/2020


**********************************************************************

     TITLE:  Upland Landfill - Daily Cover HDPE Failure C&D

**********************************************************************


     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   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
```

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	240.00	CM
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0776	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL

FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	30.855	CM
TOTAL INITIAL WATER	=	30.855	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	

START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	10.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79

STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47

RUNOFF

TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118

EVAPOTRANSPIRATION

TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	186.7819	125.4513	113.2133	58.6388	30.8218	26.7040
	20.9745	18.0658	29.6386	126.4795	184.1192	187.7798
STD. DEVIATIONS	80.2050	63.7018	46.5574	30.0269	19.8723	18.7225
	19.8969	15.6496	20.6210	56.9506	63.5764	66.5428

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	188.6486	128.9355	119.7612	68.0736	33.9717	26.5464
	22.2037	18.1844	27.7207	102.4087	175.7489	188.9156
STD. DEVIATIONS	77.3292	63.2177	46.8353	31.0103	18.5991	17.8725
	19.4788	16.0282	19.5871	47.7744	59.0323	59.0145

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	1.3349	0.9319	0.8788	0.5316	0.3067	0.2530
	0.2249	0.1920	0.2587	0.7622	1.2482	1.3379
STD. DEVIATIONS	0.5111	0.4207	0.3121	0.2068	0.1243	0.1221
	0.1338	0.1161	0.1352	0.3182	0.3916	0.3906

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.7943	0.5852	0.4853	0.2626	0.1344	0.1208
	0.0919	0.0795	0.1330	0.5385	0.8090	0.7990
STD. DEVIATIONS	0.3393	0.2970	0.1996	0.1318	0.0860	0.0840
	0.0878	0.0694	0.0929	0.2413	0.2828	0.2805

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	9.3680	7.0421	5.9621	3.5023	1.6914	1.3658
	1.1055	0.9054	1.4262	5.0953	9.0314	9.3906
STD. DEVIATIONS	3.8164	3.4486	2.3307	1.5954	0.9260	0.9195
	0.9698	0.7980	1.0077	2.3729	3.0217	2.9170

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1108.66833	(182.04721)	11086.684	74.61072
AVERAGE HEAD ON TOP	4.028	(0.658)		

OF LAYER 4				
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1101.11902	(183.70462)	11011.190	74.10267
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.26081	(1.22634)	82.608	0.55593
AVERAGE HEAD ON TOP OF LAYER 6	46.572	(7.806)		
CHANGE IN WATER STORAGE	-0.592	(2.3864)	-5.92	-0.040

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	50.805981	508.05981
AVERAGE HEAD ON TOP OF LAYER 4	75.712	
DRAINAGE COLLECTED FROM LAYER 5	20.55753	205.57533
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.132190	1.32190
AVERAGE HEAD ON TOP OF LAYER 6	300.000	
MAXIMUM HEAD ON TOP OF LAYER 6	367.829	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	33.6 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	17.5200	0.0730
4	0.0000	0.0000
5	1.0381	0.0346
6	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IF6.D10
OUTPUT DATA FILE:           C:\HELP3\88877if6.OUT


TIME:  13: 1     DATE:   5/28/2020


**********************************************************************

     TITLE:  Upland Landfill - Intermediate Cover HDPE Failure C&D

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
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                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
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LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	2400.00	CM
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0845	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL

FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1493	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	213.377	CM
TOTAL INITIAL WATER	=	213.377	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	

START OF GROWING SEASON (JULIAN DATE) = 91
END OF GROWING SEASON (JULIAN DATE) = 305
EVAPORATIVE ZONE DEPTH = 25.0 CM
AVERAGE ANNUAL WIND SPEED = 8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53

	28.36	30.28	30.04	68.74	74.24	69.47

RUNOFF

TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191

EVAPOTRANSPIRATION

TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318
STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	181.7890	159.4316	160.1953	110.0303	25.7250	12.9628
	10.3462	8.2745	15.9669	60.2012	120.0866	167.5739
STD. DEVIATIONS	64.0056	63.7747	51.0165	53.3308	26.3330	16.5620
	16.0027	12.9388	17.0056	26.7836	40.0943	47.3464

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	177.4010	165.0154	160.2038	122.3063	37.4109	13.1796
	10.6072	8.4422	13.9848	46.1568	110.2817	160.0766
STD. DEVIATIONS	55.6627	60.3891	52.6477	48.6307	32.3400	15.5460
	14.3900	12.5511	14.9529	21.9186	34.9547	43.6375

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	1.2631	1.1723	1.1483	0.8933	0.3287	0.1537
	0.1359	0.1071	0.1549	0.3833	0.8131	1.1476
STD. DEVIATIONS	0.3711	0.4049	0.3514	0.3243	0.2168	0.1125
	0.1065	0.1010	0.1112	0.1506	0.2331	0.2908

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.7717	0.7442	0.6801	0.4846	0.1104	0.0574
	0.0443	0.0354	0.0704	0.2524	0.5214	0.7095
STD. DEVIATIONS	0.2734	0.3001	0.2163	0.2344	0.1129	0.0726
	0.0683	0.0556	0.0743	0.1131	0.1758	0.2046

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	8.8321	9.0153	7.9764	6.2925	1.8627	0.6781
	0.5281	0.4203	0.7195	2.2981	5.6739	7.9697
STD. DEVIATIONS	2.7706	3.3036	2.6212	2.5020	1.6102	0.7998
	0.7165	0.6249	0.7693	1.0913	1.7984	2.1718

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.58350	(187.03522)	10325.835	69.49039
AVERAGE HEAD ON TOP OF LAYER 4	3.735	(0.687)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1025.06604	(185.51189)	10250.660	68.98448
PERCOLATION/LEAKAGE THROUGH LAYER 6	7.70132	(1.25354)	77.013	0.51828

AVERAGE HEAD ON TOP OF LAYER 6	43.556	(7.941)		
CHANGE IN WATER STORAGE	-2.497	(4.3731)	-24.97	-0.168

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	19.819096	198.19095
AVERAGE HEAD ON TOP OF LAYER 4	26.185	
DRAINAGE COLLECTED FROM LAYER 5	14.76017	147.60168
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.099524	0.99524
AVERAGE HEAD ON TOP OF LAYER 6	224.383	
MAXIMUM HEAD ON TOP OF LAYER 6	285.534	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	29.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	175.2000	0.0730
4	0.0000	0.0000
5	2.6365	0.0879
6	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FF6.D10
OUTPUT DATA FILE:           C:\HELP3\88877ff6.OUT


TIME:  14:32     DATE:   5/28/2020


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     TITLE:  Upland Landfill - Final Cover HDPE Failure C&D

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     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   4
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1785 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.170000002000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	2400.00	CM

POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0730	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0336	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	201.028	CM
TOTAL INITIAL WATER	=	201.028	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023
STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796
EVAPOTRANSPIRATION						
TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461

STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	3.1054	2.6921	2.4105	1.9812	1.4585	0.9155
	0.6563	0.4892	0.3439	0.1257	0.3705	2.2315
STD. DEVIATIONS	0.9461	0.8941	0.8601	0.5131	0.3294	0.1857
	0.1275	0.1010	0.1021	0.1032	0.4572	1.0633

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9175	2.6867	2.3969	1.9595	1.4814	0.9074
	0.6181	0.4307	0.2890	0.1172	0.1999	1.8106
STD. DEVIATIONS	0.8955	0.8763	0.8482	0.5565	0.3509	0.2053
	0.1336	0.0999	0.0949	0.0890	0.2910	1.0083

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0998	0.0911	0.0958	0.0908	0.0902	0.0838
	0.0845	0.0828	0.0782	0.0490	0.0328	0.0870
STD. DEVIATIONS	0.0060	0.0060	0.0077	0.0037	0.0023	0.0014
	0.0009	0.0029	0.0068	0.0204	0.0224	0.0174

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0133	0.0127	0.0103	0.0088	0.0063	0.0041
	0.0029	0.0022	0.0016	0.0006	0.0016	0.0095
STD. DEVIATIONS	0.0040	0.0042	0.0037	0.0023	0.0014	0.0008
	0.0005	0.0004	0.0005	0.0005	0.0020	0.0045

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1453	0.1468	0.1193	0.1008	0.0738	0.0467
	0.0308	0.0214	0.0149	0.0058	0.0103	0.0902
STD. DEVIATIONS	0.0446	0.0480	0.0422	0.0286	0.0175	0.0106
	0.0066	0.0050	0.0049	0.0044	0.0150	0.0502

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH LAYER 3	16.75417	(2.74737)	167.542	1.12752
AVERAGE HEAD ON TOP OF LAYER 3	100.540	(17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78042	(2.82040)	167.804	1.12928
AVERAGE HEAD ON TOP OF LAYER 6	0.062	(0.010)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	15.81481	(2.77546)	158.148	1.06430
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.96599	(0.03470)	9.660	0.06501
AVERAGE HEAD ON TOP OF LAYER 8	0.672	(0.119)		
CHANGE IN WATER STORAGE	-0.757	(2.5400)	-7.57	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.257808	2.57808
AVERAGE HEAD ON TOP OF LAYER 6	0.343	
DRAINAGE COLLECTED FROM LAYER 7	0.20964	2.09641
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.003990	0.03990
AVERAGE HEAD ON TOP OF LAYER 8	3.236	
MAXIMUM HEAD ON TOP OF LAYER 8	6.271	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	175.2018	0.0730
6	0.0000	0.0000
7	1.0044	0.0335
8	0.4500	0.7500
SNOW WATER	0.000	

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Appendix F
Leachate Treatment Facility Commissioning Plan

Appendix F Leachate Treatment Facility Commissioning Plan

1. Description of Leachate Treatment Works and Design

Leachate will be collected by a series of perforated pipes installed at the base of each landfill cell that discharge to a sump. Leachate will be stored temporarily in the Landfill and pumped from the sump to the Leachate Treatment Facility (LTF). Leachate will be pumped from the Landfill to the LTF for batch treatment on an as-needed basis.

The treatment system will operate in a batch treatment setup, generating a batch of effluent for infiltration. To target operation of a weekly batch at the peak daily leachate generation rate, an average batch size is considered to be 625 m^3. A batch size may vary, requiring operational adjustments to the treatment system. Based on the pond sizing described below, the maximum batch size is 1,400 m^3.

The leachate collection system for the Landfill includes the following components:

- Perforated leachate collection pipes (LCP) with minimum diameter of 150 mm wrapped in protective geotextile layers within the stone drainage blanket
- A 2.75 percent slope along primary flow path and 2 percent slope along the secondary flow path to the LCPs
- Clean-outs at each end of the LCPs
- Maximum leachate head of 0.3 m at any point on the Landfill base liner
- Leachate collection header pipe along the east side of the Landfill sloping at 2 percent towards a leachate collection sump located at the north east corner of the Landfill footprint
- A sump with bottom dimension of 3,900 mm^2
- Two leachate sump riser pipes with minimum diameters of 450 mm
- Manually operated submersible leachate pump housed in one of the two sump riser pipes

The detailed design of the treatment system will be based on process modeling results and refined based on site-specific leachate chemistry. The conceptual design is described herein. The LTF consists of an aerated equalization system, solids removal, chemical addition, further solids removal, an effluent holding pond, a granular activated carbon (GAC) filter, and an infiltration pond.

The conceptual design features of the aerated equalization pond include:

- 2.5H:1V side walls double lined with 60-mil HDPE liner overlying a GCL
- A submerged coarse bubble aeration system
- Positive displacement blowers sized to provide the required air demand
- Decant pump
- Approximate bottom dimensions of the aeration pond will be 15 metres (m) by 15 m. The approximate top dimensions of the aeration pond will be 34 m by 32 m.
- Approximate depth of 3 m with a 0.6 m freeboard

- Resulting available volume is approximately 1,400 m^3
- Provides storage capacity of over 7 days at the target average daily generation rate with 100 percent redundancy to account for peak storm events. This facilitates operation of a weekly batch treatment.
- Aeration is anticipated to require a retention time of 1-3 days
- The aerated equalization system is anticipated to be filled with automated pump shutoffs based on liquid level in the Landfill and in the pond. To fill the aeration basin over the course of 2 days. Therefore pumping capacity to fill the aerated equalization system should be 2.4 litres per second (L/s) (38 gallons per minute [gpm]) for an average size batch and 5.4 L/s (86 gpm) for a maximum size batch.

Effluent from the aerated equalization system will contain elevated concentrations of suspended solids following oxidation of metals and the presence of other inorganics. The next step is solids removal. This will be accomplished through settling in a clarifier or filtration.

Clarification or filtration will require a capacity of 7.2 L/s (115 gpm) for an average size batch and 16 L/s (259 gpm) for a maximum size batch to complete solids removal within one day.

Aeration and solids removal will remove the majority of dissolved iron and manganese. Additional dissolved metals removal may be required to achieve the discharge criteria. The dissolved metals will be removed if required by chemical precipitation, by adding a volume of chemical that will cause an increase or decrease of pH of the leachate to facilitate the formation of an insoluble salt. Chemical addition will take place in a complete mixed reactor or inline mixer.

Following chemical addition, the formulation of additional suspended solids will require solids removal using a solids removal system as described above.

Effluent from the chemical addition and solids removal step will be collected in a holding pond or tank. The effluent holding pond or tank will therefore have the necessary capacity to store a full batch with 0.6 m of freeboard.

Effluent in the effluent holding pond or tank will be sampled to determine if the discharge criteria have been achieved. If the discharge criteria are achieved, effluent will be conveyed directly to the infiltration pond.

If discharge criteria have not been achieved, the effluent will be recirculated through a granular activated carbon (GAC) filter as described below and resampled to confirm the discharge criteria are achieved prior to infiltration.

An optional GAC filter will be used to polish effluent stored in the effluent holding pond should an initial sample indicate that the effluent does not achieve the discharge criteria. A GAC filter has been selected to ensure the effluent PAH criteria can be consistently achieved.

The infiltration pond will be used to infiltrate treated leachate and some of the collected storm water into the groundwater system. The design and construction of the infiltration pond is supported by the results of the hydrogeologic characterization of the Site, as provided in the Hydrology and Hydrogeology Characterization Report (HHCR).

Discharge to the infiltration pond will meet the British Columbia (BC) Contaminated Sites Regulation (CSR) Schedule 3.2 Drinking Water (DW) Criteria. The location of the infiltration pond has been selected to allow for further natural attenuation to occur while allowing for continued Site operations. The Site is underlain by a vadose zone of varying thickness, and will be used to attenuate, via sorption, diffusion,

dilution, dispersion, and biodegradation, the treated leachate to further reduce the concentrations of the leachate constituents prior to reaching the sand and gravel aquifer and the downgradient property line.

The design and construction of the infiltration pond is supported by the results of the HHCR, and includes:

- 2:5H:1V side walls
- Maximum draining time is 48 hours
- Maximum water ponding depth is 0.3 m
- Infiltration capacity between 13 mm/hr (minimum) and 61 mm/hr (maximum)
- Minimum 600 mm free board

1.1 Treatment Process

The leachate treatment system will reduce the concentration of leachate constituents by the processes described below:

- Aeration oxidizes dissolved metals such as iron and manganese to less soluble forms and produces flocs that will be filtered. Concentrations of other metals present in the leachate that are not readily oxidized in an aeration lagoon will also be reduced when the suspended (not dissolved) components of these metals are filtered.
- Hydrocarbons and volatile organic compounds will be readily volatized in an aeration lagoon thereby reducing the concentration. If concentrations of organic compounds are required to be further reduced, the effluent will be filtered through a GAC filter.
- The dissolved metals will be removed, if required by chemical precipitation, by adding a volume of chemicals (i.e., mild acids or bases) that will cause an increase or decrease of pH of the leachate to facilitate the formation of an insoluble salt.

Should leachate quality change over time and additional leachate constituents require treatment, the process is capable of including a polishing step to continue to meet the BC CSR Schedule 3.2 Criteria.

The forecasted treated leachate quality is presented in the DOCP. Further studies will be performed on the actual leachate during the commissioning and operation of the LTF to ensure adequate level treatment is attained. The leachate treatment process may be modified throughout the life of the Landfill to ensure the performance and compliance criteria are met.

2. Commissioning Period Operating Procedures

This LTF Commissioning Plan provides for a commissioning period during which initial leachate characterization and confirmation of treatment process capabilities is conducted. The LTF will be constructed and operational prior to landfilling in Stage 1 East. The anticipated commissioning period schedule is outlined in Section 2.4.

Initial leachate batches are expected to have low concentrations of leachate parameters derived from newly placed waste as well as waste relocated from the former on-site landfill. The commissioning period operating procedure will support leachate quality characterization, and ensure that only treated leachate meeting the discharge criteria is decanted to the infiltration pond. The following sections describe the commissioning period operating procedures.

2.1 Clean Water Testing

Clean water testing is the initial step in the LTF commissioning. The hydraulic integrity of all major process ponds, tanks, pumps, piping, and appurtenance will be verified via clean water testing prior to the commencement of start-up and commissioning activities. The process equipment (blowers, pumps and aeration system) shall also be commissioned by manufacturer representatives prior to start-up activities. All necessary process chemicals must be delivered to Site prior to commissioning. Testing of all control systems should be executed to verify automatic control functions prior to initiating start-up activities.

2.2 Chemical Jar Testing

To optimize chemical dosing to suit the influent leachate characteristics, a period of on-site jar testing will be conducted at the same time as clean water testing. Influent samples will be collected to create an initial leachate profile. Chemical manufacturer's representatives or LTF operators will conduct jar tests with various chemicals and dosages to evaluate the effectiveness and appropriate dose conditions for removal of target parameters. The jar tests will be used to set initial batch volume chemical dosage rates.

2.3 Initial Batch Treatment

Initial batches will be kept small. The objective of introducing small initial batches of leachate is to develop a relationship between initial leachate quality, the effectiveness of the aeration system, the chemical dosage required to achieve effluent criteria, and the need for the GAC system. Based on the leachate quantity modeling described in the DOCP, the anticipated average volume of leachate to be treated in a batch is 625 m^3, which results in 100 percent excess capacity in the treatment system. The modeling considered the landfill stage with the highest leachate generation potential (Stage 2A). The initial small batch runs will introduce approximately 25% of the anticipated average volume of leachate. This allows for excess capacity in the LTF in the event that initial batches do not pass discharge criteria and need to be recirculated along with additional leachate.

Approximately 150 m^3 of leachate will be pumped in the aeration pond for treatment. The influent will be allowed to aerate for 2 days. The mixed liquor will then be pumped through a solids removal process, a chemical dosing/mixing tank, and a second solids removal process prior to discharging into the lined effluent holding pond. The treatment times for small initial batch treatment process will mirror the regular treatment cycle, which will be typically completed in 7 days, as follows:

Operating Sequence	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thur.
Fill	X	X					
Aerate	X	X	X				
Solids Removal, Chem. Dose/Mix, Solids Removal				X	X		
Sample					X		
Sample Turnaround	X					X	X
Recirculate/Infiltrate		X	X				

Collected leachate will be sampled, according to the commissioning period sampling program described in Section 3.0. Dependent on the analytical sampling results, leachate will either be recirculated back into the landfill for additional treatment or, if the effluent meets CSR Schedule 3.2 DW criteria, discharged into the infiltration pond.

2.4 Schedule

As previously stated, the leachate commissioning process will provide for leachate characterization and chemical dosage optimization that will allow the treatment process to be refined. Adjustments to the treatment process will be made from time to time as the leachate profile changes, though these changes are expected to occur over months and years, not days. The initial commissioning procedure described in Sections 2.1 and 2.3 is anticipated to be completed in the following timeframe:

- Clean water testing and equipment commissioning – 7 days
- Influent testing and chemical jar testing – within above 7 days
- 3 cycles of initial small batches (150 m^3 each) with sampling of influent and effluent – 21 days, with adjustments in operation to refine optimized conditions.

The anticipated duration of the commissioning period is 4 weeks.

3. Commissioning Plan

The Commissioning Plan has been developed to outline the framework for required monitoring, sampling and analysis that will be carried out during the commissioning period of the leachate treatment works.

3.1 Commissioning Period Sampling Program

During the LTF commissioning period, untreated leachate and treated leachate will be sampled regularly to develop a relationship between the parameters of concern within the leachate and the batch treatment sampling program and well to monitor the performance of the leachate treatment system and chemical dosage.

3.1.1 Raw Leachate Sampling

During the commissioning period, untreated leachate samples will be collected from the collection sump prior to discharge into the aerated equalization pond. Samples will be analyzed for the comprehensive set of parameters presented in the attached Table 1 to confirm the parameters of concern within the leachate. The raw leachate samples will aid in leachate characterization and establish a baseline for determining the effectiveness of the leachate treatment process.

3.1.2 Effluent Quality Sampling

During the commissioning period, each batch of effluent will be sampled from the effluent holding pond and analyzed for a comprehensive set of parameters to determine if a batch can be discharged to the infiltration pond. The effluent will only be discharged to the infiltration pond if the effluent meets the CSR Schedule 3.2 DW criteria. As such, timely analytical results/provision for on-site analytical testing will be critical to the successful commissioning of the LTF.

The commissioning period effluent sampling results will be used to establish the parameter list for compliance sampling throughout the operation of LTF. Based on leachate quality forecasting discussed in the DOCP, the key leachate parameters will be chemical constituents commonly found in C&D and contaminated soil leachate, including:

- Chloride
- Sulphate
- Sulphide
- Arsenic

- Boron
- Iron
- Manganese
- Sodium
- PAHs

3.1.3 Start-Up Treatment Performance Monitoring

In addition to sampling to meet discharge quality objectives, leachate will also be sampled to monitor the performance of the treatment process and to observe changes to leachate quality over time as additional waste is added to the landfill. The following parameters will be used to develop an understanding of the system performance and to assist in the operation and maintenance of the LTF:

- COD
- Alkalinity
- pH
- CSR metals
- Hardness
- TDS
- TSS

The sampling results allow the process to be refined over time in comparison to the process modeling completed during the LTF detailed design and identify trends in changes in leachate quality. Necessary changes or additions to the treatment process will be identified based on the results of this analysis.

3.2 Leachate Batch Sampling and Leachate Monitoring

Subsequent to the completion of the start-up phase, a regular leachate batch sampling program will be implemented. The program will be developed based on the results of the start-up phase sampling program and will outline the parameters to be sampled in every batch to indicate the effectiveness of the treatment process, as well as the confirmatory sampling required at the quarterly environmental monitoring events. Treated leachate batch samples will be collected from the effluent holding pond to verify compliance with the discharge criteria prior to discharge to the infiltration pond.

Samples sent to for laboratory analysis may be collected more frequently to verify the batch sampling program, and to assist in the operation and maintenance of the LTF.

4. Commissioning Report

A report summarizing the LTF commissioning activities and the results of analytical sampling will be prepared and submitted to the Director subsequent the completion of the commissioning period (outlined in Section 2.4). In general, the commissioning report will include the following information:

- Summary of commission activities including sampling activities.
- Summary of analytical results of influent leachate and effluent sampling.
- Copy of all calibration reports and laboratory analytical reports.
- Comments on any observed deficiencies in the LTF design or performance, and a plan for addressing any such deficiencies.
- Maintenance and performance monitoring plan.

5. Contingency Measures

Contingency measures are practical and implementable measures that can put in place in the event of a failure or non-compliance with site performance criteria. The following is a list of potential LTF conditions and associated potential contingency measures that could be implemented:

- Treated leachate effluent does not meet CSR Schedule 3.2 DW standards:
  - Re-circulate batch into the Landfill for retreatment in the LTF
  - Pump and haul to an off-site authorized treatment facility
- Volume of leachate exceeds forecasted treatment capacity:
  - Store leachate in approved leachate containment tanks on-site
  - Evaluate if increased volume is expected long-term and necessitates an expansion of the LTF
- Worsening trend observed in leachate effluent quality:
  - Review leachate process modeling and refine treatment process with addition of chemical
  - Modify/upgrade the leachate treatment process
  - Pre-treat and haul to an off-site authorized treatment facility
- Worsening trend observed in influent leachate quality and/or identification of new parameters of concern:
  - Review leachate process modeling and refine treatment process with addition of chemical
  - Modify/upgrade the leachate treatment process
  - Pre-treat and haul to an off-site authorized treatment facility

Analytical Parameters for Leachate
Leachate Treatment Facility Commissioning Plan
Northwin Landfill
Upland Contracting Ltd.

Field Parameters
Conductivity (field)
Dissolved oxygen
Oxidation reduction potential
pH (field)
Temperature
Total dissolved solids (TDS)
Turbidity

General Chemistry
Alkalinity (speciated)
Chemical oxygen demand (COD)
Chloride (dissolved)
Conductivity
Hardness
Hardness (dissolved)
Hydrogen sulfide
pH
Sulfate (dissolved)
Sulfide
Total dissolved solids (TDS)
Total suspended solids (TSS)

Nutrients
Ammonia-N
Nitrate (as N)
Nitrite (as N)
Nitrite/Nitrate
Total Kjeldahl Nitrogen (TKN)
Orthophosphate
Total Phosphorous (P)

Dissolved CSR Metals

Total CSR Metals

Polycyclic Aromatic Hydrocarbons

BTEX/Volatile Petroleum Hydrocarbons

Extractable petroleum hydrocarbons (EPH)

Appendix G
Contaminating Lifespan Assessment Calculations

Appendix G

Chloride (1st Order)
British Columbia CSR Contaminating Life Span of Chloride

Drinking Water Land Use
Maximum Anticipated Concentration

C_t	250	mg/L	
C_B	1500	mg/L	
λ	0.065	y^{-1}	
t	27.57	y	Time to reduce below Criteria
t	28	y	Time, rounded up
C_o	243.04	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration from the investigated Sites listed in the Leachate Profile tab.

Note: First order decay rate obtained from Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.

Appendix G

Chloride - Rowe Model
British Columbia CSR Contaminating Life Span of Chloride

Drinking Water Land Use

	Scenario 1	Scenario 2	Units	Comments
C_t	250	250	mg/L	Target concentration
C_t	0.25	0.25	kg/m^3	Target concentration
q_o	0.017	0.017	m/y	Average rate of infiltration
p	0.0004	0.00064	-	Proportion of total waste mass that is chloride
A_o	36,000	36,000	m^2	Unit area[2]
V_o	532,365	532,365	m^3	Volume of landfill
C_o	1500	1500	mg/L	Chloride concentration (peak or average)
C_o	1.5	1.5	kg/m^3	Chloride concentration (peak or average)
r_{dw}	1300	1300	kg/m^3	Dry density of waste
M_o	692,074,500	692,074,500	kg	
H_r	5.13	8.20	m	Reference height of leachate
λ	0.065	0.065	y^{-1}	First Order decay constant
k	0.0683	0.0671	y^{-1}	
k	0.0033	0.0021	y^{-1}	
t	**26.23**	**26.71**	**years**	
t			years	
q_o			m/y	Infiltration rate required to achieve CLS = 30 years

Scenario 1 Maximum chloride concentration, average proportion of chloride in waste
Scenario 2 Maximum chloride concentration, maximum proportion of chloride in waste

Notes

1. The Modified Rowe Model calculates the contaminating life span using a unit area of 1 sq. m. at the highest point of the landfill.

2. The Rowe Model, utilizes the total area of the landfill, as described in "*Rowe, 1995, Leachate characteristics for MSW landfills, R.K. Rowe, Geotechnical Research Centre Report, GEOT 8 95*".

3. The proportion of total waste mass that is chloride was determined for Brooks Road Landfill, based on analytical studies.

4. First order decay rate obtained from *Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.*

Appendix G

Copper - 1st Order
British Columbia CSR Contaminating Life Span of Copper

Drinking Water Land Use
Maximum Anticipated Concentration

C_t	1	mg/L	
C_B	0.05	mg/L	
λ	0.2	y^{-1}	
t	-14.98	y	Time to reduce below Criteria
t	-15	y	Time, rounded up
C_o	1.00	mg/L	Check at t (rounded up)

From Column AI

C_t	0.5	mg/L	
C_B	0.05	mg/L	
λ	0.2	y^{-1}	
t	-11.51	y	Time to reduce below Criteria
t	-12	y	Time, rounded up
C_o	0.55	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration from the investigated Sites listed in the Leachate Profile tab.

Note: First order decay rate obtained from Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.

Appendix G

Sulphate 1st Order
British Columbia CSR Contaminating Life Span of Sulphate

Drinking Water Land Use
Maximum Anticipated Concentration

C_t	500	mg/L	
C_B	1000	mg/L	
λ	0.079	y^{-1}	
t	8.77	y	Time to reduce below Criteria
t	9	y	Time, rounded up
C_o	491.15	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration from the investigated Sites listed in the Leachate Profile tab.

Note: First order decay rate obtained from Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.

Appendix H
Liner Leakage HELP Model Results

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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:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DF6.D10
OUTPUT DATA FILE:           C:\HELP3\88877DF6.OUT

TIME:  17:16     DATE:   3/20/2018

**********************************************************************

     TITLE:  Upland Landfill - Daily Cover HDPE Failure, Secondary Liner

**********************************************************************

     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   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3171	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0389	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	30.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0700	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	150.0	METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM

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	=	2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00 HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60 CM
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	768.778	CM
TOTAL INITIAL WATER	=	768.778	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	10.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118
EVAPOTRANSPIRATION						
TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	69.2439	87.4646	106.1008	128.8358	138.5320	121.7064
	116.7813	105.4236	84.6364	53.9413	43.1807	54.1387
STD. DEVIATIONS	25.0072	31.9981	33.4254	32.8829	29.1002	22.3601
	18.7912	16.9541	17.0074	16.5754	15.7972	19.9535
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	65.1089	84.2772	102.4533	123.0865	138.0491	123.4093
	117.0968	106.9451	86.7352	60.5727	43.3287	50.4224
STD. DEVIATIONS	24.4978	28.8200	30.3134	31.9586	29.0905	23.2966
	18.4311	17.3214	15.8749	16.8588	14.9788	17.0222
PERCOLATION/LEAKAGE THROUGH LAYER 6						

TOTALS	0.5145	0.6352	0.7635	0.8985	1.0008	0.9006
	0.8611	0.7934	0.6561	0.4842	0.3667	0.4165
STD. DEVIATIONS	0.1633	0.1923	0.2021	0.2131	0.1940	0.1553
	0.1229	0.1155	0.1058	0.1124	0.0999	0.1135

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.6456	0.5848	0.6505	0.6482	0.7019	0.7062
	0.7462	0.7551	0.7290	0.7374	0.6806	0.6708
STD. DEVIATIONS	0.0759	0.0686	0.0741	0.0698	0.0734	0.0730
	0.0750	0.0748	0.0717	0.0725	0.0683	0.0676

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001
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 (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0748	0.1027	0.1130	0.1417	0.1474	0.1339
	0.1243	0.1123	0.0931	0.0583	0.0487	0.0588
STD. DEVIATIONS	0.0262	0.0367	0.0354	0.0362	0.0310	0.0245
	0.0201	0.0180	0.0187	0.0175	0.0170	0.0209

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	3.2417	4.6031	5.1011	6.3327	6.8734	6.3493
	5.8302	5.3247	4.4624	3.0159	2.2292	2.5105
STD. DEVIATIONS	1.2197	1.5665	1.5093	1.6442	1.4484	1.1986
	0.9177	0.8624	0.8167	0.8394	0.7706	0.8475

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	1.5592	1.5497	1.5711	1.6177	1.6952	1.7623
	1.8021	1.8236	1.8193	1.7809	1.6984	1.6200
STD. DEVIATIONS	0.1833	0.1783	0.1788	0.1742	0.1774	0.1822
	0.1812	0.1807	0.1789	0.1751	0.1705	0.1632

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1109.98572	(153.82428)	11099.857	74.69937
AVERAGE HEAD ON TOP OF LAYER 4	1.007	(0.139)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1101.48511	(150.58197)	11014.852	74.12730
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.29104	(1.00393)	82.910	0.55797
AVERAGE HEAD ON TOP OF LAYER 6	46.562	(6.368)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	8.25641	(0.77981)	82.564	0.55564
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00175	(0.00017)	0.017	0.00012

AVERAGE HEAD ON TOP OF LAYER 8	16.916	(1.597)		
CHANGE IN WATER STORAGE	-0.955	(7.3122)	-9.55	-0.064

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.922950	89.22950
AVERAGE HEAD ON TOP OF LAYER 4	2.946	
DRAINAGE COLLECTED FROM LAYER 5	7.72807	77.28065
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.054120	0.54120
AVERAGE HEAD ON TOP OF LAYER 6	119.280	
MAXIMUM HEAD ON TOP OF LAYER 6	170.266	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.9 METERS	
DRAINAGE COLLECTED FROM LAYER 7	0.02983	0.29826
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000006	0.00006
AVERAGE HEAD ON TOP OF LAYER 8	22.330	
MAXIMUM HEAD ON TOP OF LAYER 8	42.487	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	7.2 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	746.7070	0.3111
4	0.0000	0.0000
5	3.2624	0.1087
6	0.4500	0.7500
7	2.4275	0.0809
8	0.0000	0.0000
9	0.4500	0.7500
SNOW WATER	0.000	

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**                                                                  **
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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DF5.D10
OUTPUT DATA FILE:           C:\HELP3\88877DF5.OUT

TIME:  17: 0     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Daily Cover HDPE Failure

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     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   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3171	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0389	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	766.230	CM
TOTAL INITIAL WATER	=	766.230	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	10.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118
EVAPOTRANSPIRATION						
TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	69.2439	87.4646	106.1008	128.8358	138.5320	121.7064
	116.7813	105.4236	84.6364	53.9413	43.1807	54.1387
STD. DEVIATIONS	25.0072	31.9981	33.4254	32.8829	29.1002	22.3601
	18.7912	16.9541	17.0074	16.5754	15.7972	19.9535
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	65.1089	84.2772	102.4533	123.0865	138.0491	123.4093
	117.0968	106.9451	86.7352	60.5727	43.3287	50.4224

STD. DEVIATIONS	24.4978	28.8200	30.3134	31.9586	29.0905	23.2966
	18.4311	17.3214	15.8749	16.8588	14.9788	17.0222

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.5145	0.6352	0.7635	0.8985	1.0008	0.9006
	0.8611	0.7934	0.6561	0.4842	0.3667	0.4165
STD. DEVIATIONS	0.1633	0.1923	0.2021	0.2131	0.1940	0.1553
	0.1229	0.1155	0.1058	0.1124	0.0999	0.1135

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0748	0.1027	0.1130	0.1417	0.1474	0.1339
	0.1243	0.1123	0.0931	0.0583	0.0487	0.0588
STD. DEVIATIONS	0.0262	0.0367	0.0354	0.0362	0.0310	0.0245
	0.0201	0.0180	0.0187	0.0175	0.0170	0.0209

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	3.2417	4.6031	5.1011	6.3327	6.8734	6.3493
	5.8302	5.3247	4.4624	3.0159	2.2292	2.5105
STD. DEVIATIONS	1.2197	1.5665	1.5093	1.6442	1.4484	1.1986
	0.9177	0.8624	0.8167	0.8394	0.7706	0.8475

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1109.98572	(153.82428)	11099.857	74.69937
AVERAGE HEAD ON TOP OF LAYER 4	1.007	(0.139)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1101.48511	(150.58197)	11014.852	74.12730
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.29104	(1.00393)	82.910	0.55797
AVERAGE HEAD ON TOP OF LAYER 6	46.562	(6.368)		
CHANGE IN WATER STORAGE	-0.988	(7.3143)	-9.88	-0.066

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.922950	89.22950
AVERAGE HEAD ON TOP OF LAYER 4	2.946	
DRAINAGE COLLECTED FROM LAYER 5	7.72807	77.28065
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.054120	0.54120
AVERAGE HEAD ON TOP OF LAYER 6	119.280	
MAXIMUM HEAD ON TOP OF LAYER 6	170.266	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	746.7070	0.3111
4	0.0000	0.0000
5	3.2624	0.1087
6	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DO3.D10
OUTPUT DATA FILE:           C:\HELP3\88877DO3.OUT

TIME:  16:43     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Daily Cover DOCP - Poor Liner Install

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     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   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3171	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0390	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM
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	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT

SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	766.234	CM
TOTAL INITIAL WATER	=	766.234	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	10.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118
EVAPOTRANSPIRATION						
TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910

STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	69.2439	87.4646	106.1008	128.8358	138.5320	121.7064
	116.7813	105.4236	84.6364	53.9413	43.1807	54.1387
STD. DEVIATIONS	25.0072	31.9981	33.4254	32.8829	29.1002	22.3601
	18.7912	16.9541	17.0074	16.5754	15.7972	19.9535

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	65.5990	84.8830	103.1995	123.9468	139.0431	124.3204
	117.9639	107.7494	87.4097	61.1019	43.6985	50.8228
STD. DEVIATIONS	24.6491	28.9861	30.4956	32.1618	29.2816	23.4550
	18.5503	17.4347	15.9752	16.9680	15.0715	17.1150

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0020	0.0028	0.0035	0.0044	0.0050	0.0043
	0.0040	0.0036	0.0028	0.0018	0.0013	0.0015
STD. DEVIATIONS	0.0009	0.0012	0.0013	0.0015	0.0014	0.0010
	0.0008	0.0007	0.0006	0.0006	0.0005	0.0006

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0748	0.1027	0.1130	0.1417	0.1474	0.1339
	0.1243	0.1123	0.0931	0.0583	0.0487	0.0588
STD. DEVIATIONS	0.0262	0.0367	0.0354	0.0362	0.0310	0.0245
	0.0201	0.0180	0.0187	0.0175	0.0170	0.0209

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	3.2661	4.6362	5.1382	6.3769	6.9228	6.3961
	5.8733	5.3648	4.4971	3.0422	2.2482	2.5304
STD. DEVIATIONS	1.2273	1.5755	1.5183	1.6547	1.4579	1.2067
	0.9236	0.8681	0.8219	0.8448	0.7754	0.8521

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1109.98572	(153.82428)	11099.857	74.69937
AVERAGE HEAD ON TOP OF LAYER 4	1.007	(0.139)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1109.73792	(151.56952)	11097.379	74.68269
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.03697	(0.00634)	0.370	0.00249
AVERAGE HEAD ON TOP OF LAYER 6	46.910	(6.410)		
CHANGE IN WATER STORAGE	-0.987	(7.3146)	-9.87	-0.066

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.922950	89.22950
AVERAGE HEAD ON TOP OF LAYER 4	2.946	
DRAINAGE COLLECTED FROM LAYER 5	7.77760	77.77605
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000338	0.00338
AVERAGE HEAD ON TOP OF LAYER 6	120.045	
MAXIMUM HEAD ON TOP OF LAYER 6	171.162	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	23.0 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	746.7070	0.3111
4	0.0000	0.0000
5	3.2790	0.1093
6	0.0000	0.0000
7	0.4500	0.7500
SNOW WATER	0.000	

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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:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FF4.D10
OUTPUT DATA FILE:           C:\HELP3\88877FF4.OUT

TIME:  19:10     DATE:   3/20/2018

**********************************************************************

     TITLE:  Upland Landfill - Final Cover HDPE Failure, Secondary Liner

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
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                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   4
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1785 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0337	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 9

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	30.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0632	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	150.0	METERS

LAYER 10

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM
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	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 11

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL

WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	728.972	CM
TOTAL INITIAL WATER	=	728.972	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023
STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796

EVAPOTRANSPIRATION

TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461
STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	3.1055	2.6911	2.4135	1.9825	1.4584	0.9163
	0.6560	0.4896	0.3444	0.1259	0.3696	2.2274
STD. DEVIATIONS	0.9502	0.8980	0.8627	0.5128	0.3316	0.1868
	0.1274	0.1012	0.1021	0.1036	0.4582	1.0603

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9168	2.6859	2.3986	1.9599	1.4829	0.9079
	0.6186	0.4310	0.2893	0.1173	0.1984	1.8080
STD. DEVIATIONS	0.8955	0.8772	0.8500	0.5565	0.3525	0.2060
	0.1340	0.1000	0.0949	0.0888	0.2906	1.0078

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0998	0.0911	0.0958	0.0908	0.0902	0.0838
	0.0845	0.0828	0.0782	0.0490	0.0329	0.0870
STD. DEVIATIONS	0.0060	0.0060	0.0077	0.0037	0.0024	0.0014
	0.0009	0.0030	0.0067	0.0205	0.0223	0.0174

LATERAL DRAINAGE COLLECTED FROM LAYER 9

TOTALS	0.0776	0.0728	0.0817	0.0804	0.0840	0.0817
	0.0845	0.0844	0.0815	0.0828	0.0749	0.0760
STD. DEVIATIONS	0.0046	0.0040	0.0039	0.0035	0.0033	0.0029

	0.0027	0.0024	0.0021	0.0024	0.0029	0.0031

PERCOLATION/LEAKAGE THROUGH LAYER 11

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 (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0030	0.0029	0.0024	0.0020	0.0014	0.0009
	0.0006	0.0005	0.0003	0.0001	0.0004	0.0022
STD. DEVIATIONS	0.0009	0.0010	0.0008	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0005	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1452	0.1468	0.1194	0.1008	0.0738	0.0467
	0.0308	0.0215	0.0149	0.0058	0.0102	0.0900
STD. DEVIATIONS	0.0446	0.0481	0.0423	0.0286	0.0176	0.0106
	0.0067	0.0050	0.0049	0.0044	0.0150	0.0502

DAILY AVERAGE HEAD ON TOP OF LAYER 10

AVERAGES	0.1875	0.1930	0.1973	0.2006	0.2029	0.2039
	0.2042	0.2039	0.2033	0.2001	0.1868	0.1834
STD. DEVIATIONS	0.0111	0.0100	0.0094	0.0088	0.0080	0.0073
	0.0066	0.0059	0.0053	0.0058	0.0072	0.0075

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH LAYER 3	16.75417	(2.74737)	167.542	1.12752
AVERAGE HEAD ON TOP OF LAYER 3	100.540	(17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78025	(2.82458)	167.803	1.12927
AVERAGE HEAD ON TOP OF LAYER 6	0.014	(0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	15.81461	(2.77709)	158.146	1.06429
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.96615	(0.03470)	9.662	0.06502
AVERAGE HEAD ON TOP OF LAYER 8	0.672	(0.119)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.96240	(0.03525)	9.624	0.06477
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00020	(0.00001)	0.002	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	1.973	(0.072)		
CHANGE IN WATER STORAGE	-0.753	(2.5401)	-7.53	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.317653	3.17653
AVERAGE HEAD ON TOP OF LAYER 6	0.084	
DRAINAGE COLLECTED FROM LAYER 7	0.21372	2.13717
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.004017	0.04017
AVERAGE HEAD ON TOP OF LAYER 8	3.299	
MAXIMUM HEAD ON TOP OF LAYER 8	6.390	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
DRAINAGE COLLECTED FROM LAYER 9	0.00287	0.02873
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000001	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	2.151	
MAXIMUM HEAD ON TOP OF LAYER 10	4.253	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	1.7 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	700.8000	0.2920
6	0.0000	0.0000
7	1.0047	0.0335
8	0.4500	0.7500
9	1.9316	0.0644
10	0.0000	0.0000
11	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FF3.D10
OUTPUT DATA FILE:           C:\HELP3\88877FF3.OUT

TIME:  18:51     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Final Cover HDPE Failure

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     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   4
          THICKNESS                   =     15.00   CM
          POROSITY                    =      0.4370 VOL/VOL
          FIELD CAPACITY              =      0.1050 VOL/VOL
          WILTING POINT               =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.1785 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0337	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	726.626	CM
TOTAL INITIAL WATER	=	726.626	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023

STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796

EVAPOTRANSPIRATION

TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461
STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	3.1055	2.6911	2.4135	1.9825	1.4584	0.9163
	0.6560	0.4896	0.3444	0.1259	0.3696	2.2274
STD. DEVIATIONS	0.9502	0.8980	0.8627	0.5128	0.3316	0.1868
	0.1274	0.1012	0.1021	0.1036	0.4582	1.0603

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9168	2.6859	2.3986	1.9599	1.4829	0.9079
	0.6186	0.4310	0.2893	0.1173	0.1984	1.8080
STD. DEVIATIONS	0.8955	0.8772	0.8500	0.5565	0.3525	0.2060
	0.1340	0.1000	0.0949	0.0888	0.2906	1.0078

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0998	0.0911	0.0958	0.0908	0.0902	0.0838
	0.0845	0.0828	0.0782	0.0490	0.0329	0.0870
STD. DEVIATIONS	0.0060	0.0060	0.0077	0.0037	0.0024	0.0014
	0.0009	0.0030	0.0067	0.0205	0.0223	0.0174

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0030	0.0029	0.0024	0.0020	0.0014	0.0009
	0.0006	0.0005	0.0003	0.0001	0.0004	0.0022
STD. DEVIATIONS	0.0009	0.0010	0.0008	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0005	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1452	0.1468	0.1194	0.1008	0.0738	0.0467
	0.0308	0.0215	0.0149	0.0058	0.0102	0.0900
STD. DEVIATIONS	0.0446	0.0481	0.0423	0.0286	0.0176	0.0106
	0.0067	0.0050	0.0049	0.0044	0.0150	0.0502

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH	16.75417	(2.74737)	167.542	1.12752

LAYER 3				
AVERAGE HEAD ON TOP OF LAYER 3	100.540 (	17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78025 (	2.82458)	167.803	1.12927
AVERAGE HEAD ON TOP OF LAYER 6	0.014 (	0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	15.81461 (	2.77709)	158.146	1.06429
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.96615 (	0.03470)	9.662	0.06502
AVERAGE HEAD ON TOP OF LAYER 8	0.672 (	0.119)		
CHANGE IN WATER STORAGE	-0.757 (	2.5401)	-7.57	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.317653	3.17653
AVERAGE HEAD ON TOP OF LAYER 6	0.084	
DRAINAGE COLLECTED FROM LAYER 7	0.21372	2.13717
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.004017	0.04017
AVERAGE HEAD ON TOP OF LAYER 8	3.299	
MAXIMUM HEAD ON TOP OF LAYER 8	6.390	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	700.8000	0.2920
6	0.0000	0.0000
7	1.0047	0.0335
8	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FO3.D10
OUTPUT DATA FILE:           C:\HELP3\88877FO3.OUT

TIME:  18:31     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Final Cover DOCP, Poor Liner

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     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   4
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1785 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0337	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15 CM
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	=	2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00 HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60 CM
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	726.627	CM
TOTAL INITIAL WATER	=	726.627	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	30.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023
STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796
EVAPOTRANSPIRATION						
TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461
STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	3.1055	2.6911	2.4135	1.9825	1.4584	0.9163
	0.6560	0.4896	0.3444	0.1259	0.3696	2.2274
STD. DEVIATIONS	0.9502	0.8980	0.8627	0.5128	0.3316	0.1868
	0.1274	0.1012	0.1021	0.1036	0.4582	1.0603

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	3.0155	2.7773	2.4950	2.0511	1.5738	0.9922
	0.7034	0.5141	0.3679	0.1767	0.2255	1.8878
STD. DEVIATIONS	0.9012	0.8827	0.8567	0.5604	0.3550	0.2075
	0.1349	0.1015	0.0983	0.1032	0.3019	1.0230

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
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 (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0030	0.0029	0.0024	0.0020	0.0014	0.0009
	0.0006	0.0005	0.0003	0.0001	0.0004	0.0022
STD. DEVIATIONS	0.0009	0.0010	0.0008	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0005	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1501	0.1518	0.1242	0.1055	0.0784	0.0510
	0.0350	0.0256	0.0189	0.0088	0.0116	0.0940
STD. DEVIATIONS	0.0449	0.0484	0.0427	0.0288	0.0177	0.0107
	0.0067	0.0051	0.0051	0.0051	0.0155	0.0509

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH LAYER 3	16.75417	(2.74737)	167.542	1.12752
AVERAGE HEAD ON TOP OF LAYER 3	100.540	(17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78025	(2.82458)	167.803	1.12927
AVERAGE HEAD ON TOP OF LAYER 6	0.014	(0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	16.78024	(2.80397)	167.802	1.12927
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00052	(0.00007)	0.005	0.00004
AVERAGE HEAD ON TOP OF LAYER 8	0.712	(0.120)		
CHANGE IN WATER STORAGE	-0.757	(2.5401)	-7.57	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.317653	3.17653
AVERAGE HEAD ON TOP OF LAYER 6	0.084	
DRAINAGE COLLECTED FROM LAYER 7	0.21737	2.17370
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000006	0.00006
AVERAGE HEAD ON TOP OF LAYER 8	3.355	
MAXIMUM HEAD ON TOP OF LAYER 8	6.496	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	700.8000	0.2920
6	0.0000	0.0000
7	1.0066	0.0336
8	0.0000	0.0000
9	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IF4.D10
OUTPUT DATA FILE:           C:\HELP3\88877IF4.OUT


TIME:  18:12     DATE:   3/20/2018


**********************************************************************

     TITLE:  Upland Landfill - Intermediate Cover HDPE Failure, 2nd Liner

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     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   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3168	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0376	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	30.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0686	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	150.0	METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM

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	=	2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00 HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60 CM
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	770.119	CM
TOTAL INITIAL WATER	=	770.119	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	25.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191
EVAPOTRANSPIRATION						
TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318
STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	58.0651	76.8939	96.6407	124.7807	140.4466	120.9064
	111.2840	99.9794	80.1117	47.1365	32.8381	42.9325
STD. DEVIATIONS	23.8355	30.0348	33.1503	32.2252	27.5298	22.7987
	21.2783	21.2336	20.0711	16.7919	13.2887	17.5842
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	54.2613	73.3592	92.7060	117.4078	139.5856	122.9260
	112.8487	101.0570	82.7143	54.8109	32.8243	39.5423
STD. DEVIATIONS	23.4180	26.8001	29.4715	31.4007	28.0702	23.4989
	20.3881	21.6544	19.3005	17.9345	12.5164	14.7287
PERCOLATION/LEAKAGE THROUGH LAYER 6						

TOTALS	0.4421	0.5624	0.6985	0.8606	1.0111	0.8974
	0.8328	0.7542	0.6293	0.4457	0.2966	0.3440
STD. DEVIATIONS	0.1561	0.1788	0.1965	0.2094	0.1872	0.1567
	0.1359	0.1444	0.1287	0.1198	0.0835	0.0982

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.5994	0.5398	0.5987	0.5978	0.6542	0.6655
	0.7071	0.7160	0.6919	0.6997	0.6420	0.6276
STD. DEVIATIONS	0.0760	0.0674	0.0717	0.0664	0.0689	0.0680
	0.0710	0.0728	0.0723	0.0757	0.0709	0.0690

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
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 (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0628	0.0903	0.1030	0.1373	0.1495	0.1331
	0.1185	0.1064	0.0881	0.0510	0.0373	0.0469
STD. DEVIATIONS	0.0248	0.0346	0.0350	0.0355	0.0293	0.0250
	0.0226	0.0227	0.0221	0.0177	0.0143	0.0182

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	2.7016	4.0066	4.6158	6.0405	6.9498	6.3244
	5.6186	5.0315	4.2556	2.7290	1.6888	1.9688
STD. DEVIATIONS	1.1660	1.4561	1.4674	1.6155	1.3976	1.2090
	1.0151	1.0781	0.9930	0.8929	0.6440	0.7333

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	1.4475	1.4303	1.4460	1.4918	1.5798	1.6609
	1.7076	1.7292	1.7267	1.6899	1.6022	1.5156
STD. DEVIATIONS	0.1835	0.1756	0.1732	0.1657	0.1663	0.1698
	0.1715	0.1758	0.1805	0.1829	0.1770	0.1666

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.01562	(152.68977)	10320.156	69.45217
AVERAGE HEAD ON TOP OF LAYER 4	0.937	(0.138)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1024.04333	(149.77515)	10240.434	68.91566
PERCOLATION/LEAKAGE THROUGH LAYER 6	7.77460	(0.99879)	77.746	0.52321
AVERAGE HEAD ON TOP OF LAYER 6	43.276	(6.318)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	7.73966	(0.75371)	77.397	0.52086
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00163	(0.00017)	0.016	0.00011

AVERAGE HEAD ON TOP OF LAYER 8	15.856	(1.544)		
CHANGE IN WATER STORAGE	-1.514	(7.2416)	-15.14	-0.102

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.388575	83.88574
AVERAGE HEAD ON TOP OF LAYER 4	2.770	
DRAINAGE COLLECTED FROM LAYER 5	7.34898	73.48981
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.051592	0.51592
AVERAGE HEAD ON TOP OF LAYER 6	113.429	
MAXIMUM HEAD ON TOP OF LAYER 6	163.361	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.4 METERS	
DRAINAGE COLLECTED FROM LAYER 7	0.02808	0.28082
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000006	0.00006
AVERAGE HEAD ON TOP OF LAYER 8	21.024	
MAXIMUM HEAD ON TOP OF LAYER 8	40.090	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	6.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	738.4622	0.3077
4	0.0000	0.0000
5	3.1061	0.1035
6	0.4500	0.7500
7	2.3897	0.0797
8	0.0000	0.0000
9	0.4500	0.7500
SNOW WATER	0.000	

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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       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IF3.D10
OUTPUT DATA FILE:           C:\HELP3\88877IF3.OUT

TIME:  17:54     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Intermediate Cover HDPE Failure

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     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   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3168	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0376	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	767.613	CM
TOTAL INITIAL WATER	=	767.613	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	25.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191
EVAPOTRANSPIRATION						
TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318
STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	58.0651	76.8939	96.6407	124.7807	140.4466	120.9064
	111.2840	99.9794	80.1117	47.1365	32.8381	42.9325
STD. DEVIATIONS	23.8355	30.0348	33.1503	32.2252	27.5298	22.7987
	21.2783	21.2336	20.0711	16.7919	13.2887	17.5842
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	54.2613	73.3592	92.7060	117.4078	139.5856	122.9260
	112.8487	101.0570	82.7143	54.8109	32.8243	39.5423

STD. DEVIATIONS	23.4180	26.8001	29.4715	31.4007	28.0702	23.4989
	20.3881	21.6544	19.3005	17.9345	12.5164	14.7287

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.4421	0.5624	0.6985	0.8606	1.0111	0.8974
	0.8328	0.7542	0.6293	0.4457	0.2966	0.3440
STD. DEVIATIONS	0.1561	0.1788	0.1965	0.2094	0.1872	0.1567
	0.1359	0.1444	0.1287	0.1198	0.0835	0.0982

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0628	0.0903	0.1030	0.1373	0.1495	0.1331
	0.1185	0.1064	0.0881	0.0510	0.0373	0.0469
STD. DEVIATIONS	0.0248	0.0346	0.0350	0.0355	0.0293	0.0250
	0.0226	0.0227	0.0221	0.0177	0.0143	0.0182

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	2.7016	4.0066	4.6158	6.0405	6.9498	6.3244
	5.6186	5.0315	4.2556	2.7290	1.6888	1.9688
STD. DEVIATIONS	1.1660	1.4561	1.4674	1.6155	1.3976	1.2090
	1.0151	1.0781	0.9930	0.8929	0.6440	0.7333

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.01562	(152.68977)	10320.156	69.45217
AVERAGE HEAD ON TOP OF LAYER 4	0.937	(0.138)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1024.04333	(149.77515)	10240.434	68.91566
PERCOLATION/LEAKAGE THROUGH LAYER 6	7.77460	(0.99879)	77.746	0.52321
AVERAGE HEAD ON TOP OF LAYER 6	43.276	(6.318)		
CHANGE IN WATER STORAGE	-1.547	(7.2462)	-15.47	-0.104

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.388575	83.88574
AVERAGE HEAD ON TOP OF LAYER 4	2.770	
DRAINAGE COLLECTED FROM LAYER 5	7.34898	73.48981
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.051592	0.51592
AVERAGE HEAD ON TOP OF LAYER 6	113.429	
MAXIMUM HEAD ON TOP OF LAYER 6	163.361	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.4 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	738.4622	0.3077
4	0.0000	0.0000
5	3.1061	0.1035
6	0.4500	0.7500
SNOW WATER	0.000	

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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    **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IO3.D10
OUTPUT DATA FILE:           C:\HELP3\88877IO3.OUT

TIME:  17:35     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Intermediate Cover DOCP, Poor Liner

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     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   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3168	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
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.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0377	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM
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	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT

SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	767.617	CM
TOTAL INITIAL WATER	=	767.617	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	25.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191
EVAPOTRANSPIRATION						
TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318

STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	58.0651	76.8939	96.6407	124.7807	140.4466	120.9064
	111.2840	99.9794	80.1117	47.1365	32.8381	42.9325
STD. DEVIATIONS	23.8355	30.0348	33.1503	32.2252	27.5298	22.7987
	21.2783	21.2336	20.0711	16.7919	13.2887	17.5842

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	54.6802	73.8920	93.3843	118.2234	140.5836	123.8392
	113.6935	101.8211	83.3620	55.3058	33.1269	39.8708
STD. DEVIATIONS	23.5611	26.9538	29.6455	31.6005	28.2545	23.6575
	20.5187	21.7955	19.4253	18.0545	12.5936	14.8075

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0016	0.0024	0.0031	0.0041	0.0051	0.0043
	0.0038	0.0033	0.0026	0.0016	0.0009	0.0011
STD. DEVIATIONS	0.0008	0.0010	0.0012	0.0014	0.0013	0.0010
	0.0008	0.0008	0.0007	0.0006	0.0004	0.0005

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0628	0.0903	0.1030	0.1373	0.1495	0.1331
	0.1185	0.1064	0.0881	0.0510	0.0373	0.0469
STD. DEVIATIONS	0.0248	0.0346	0.0350	0.0355	0.0293	0.0250
	0.0226	0.0227	0.0221	0.0177	0.0143	0.0182

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	2.7225	4.0357	4.6495	6.0825	6.9995	6.3714
	5.6607	5.0696	4.2889	2.7536	1.7043	1.9851
STD. DEVIATIONS	1.1731	1.4644	1.4760	1.6258	1.4068	1.2172
	1.0216	1.0852	0.9994	0.8989	0.6479	0.7373

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.01562	(152.68977)	10320.156	69.45217
AVERAGE HEAD ON TOP OF LAYER 4	0.937	(0.138)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1031.78259	(150.75797)	10317.826	69.43649
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.03408	(0.00607)	0.341	0.00229
AVERAGE HEAD ON TOP OF LAYER 6	43.603	(6.360)		
CHANGE IN WATER STORAGE	-1.546	(7.2464)	-15.46	-0.104

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.388575	83.88574
AVERAGE HEAD ON TOP OF LAYER 4	2.770	
DRAINAGE COLLECTED FROM LAYER 5	7.39569	73.95686
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000315	0.00315
AVERAGE HEAD ON TOP OF LAYER 6	114.150	
MAXIMUM HEAD ON TOP OF LAYER 6	164.216	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** 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 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	738.4622	0.3077
4	0.0000	0.0000
5	3.1216	0.1041
6	0.0000	0.0000
7	0.4500	0.7500
SNOW WATER	0.000	

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Appendix I
Downgradient HELP Model Results

```
*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              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:\HELP3\88877\PPT1.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877\TEMP.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877\SRAD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877\EVAP.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877\DWNGR.D10
OUTPUT DATA FILE:           C:\HELP3\88877\DWNGRO.OUT


TIME:  16:36     DATE:   5/30/2017


*******************************************************************************

     TITLE:  Upland Landfill - DOWNGRADIENT

*******************************************************************************


     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   1
          THICKNESS                    =   3500.00   CM
          POROSITY                     =      0.4170 VOL/VOL
          FIELD CAPACITY               =      0.0450 VOL/VOL
          WILTING POINT                =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0757 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC
```

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 1.80
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 3.% AND
A SLOPE LENGTH OF 200. METERS.

SCS RUNOFF CURVE NUMBER	=	71.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.597	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	12.510	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.540	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	264.820	CM
TOTAL INITIAL WATER	=	264.820	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	3.934	14.270	1.151	0.004	0.004	0.000
	0.001	0.065	0.001	0.883	1.951	1.639
STD. DEVIATIONS	13.587	54.972	8.056	0.036	0.032	0.000
	0.014	0.626	0.008	1.913	4.537	2.905
EVAPOTRANSPIRATION						
TOTALS	7.840	13.199	40.143	67.513	56.813	50.345

	32.543	28.117	33.634	22.952	9.510	7.228
STD. DEVIATIONS	2.334	3.971	4.979	12.991	21.388	22.293
	21.697	19.702	17.191	5.052	1.334	1.686

PERCOLATION/LEAKAGE THROUGH LAYER 1

TOTALS	71.9297	98.2503	122.8276	137.1311	137.3340	113.6443
	100.3723	88.5671	71.0573	46.5177	33.3858	47.1655
STD. DEVIATIONS	26.3691	35.3745	38.3219	35.3850	29.2549	22.0743
	17.4402	14.6448	13.3432	13.2981	12.2372	15.9583

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	23.902	(65.8864)	239.02	1.609
EVAPOTRANSPIRATION	369.840	(52.3562)	3698.40	24.889
PERCOLATION/LEAKAGE THROUGH LAYER 1	1068.18250	(190.94087)	10681.825	71.88612
CHANGE IN WATER STORAGE	24.012	(9.0187)	240.12	1.616

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	76.924	769.2419
PERCOLATION/LEAKAGE THROUGH LAYER 1	10.355275	103.55275
SNOW WATER	304.80	3048.0220

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3769
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0180

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****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	504.9421	0.1443
SNOW WATER	0.000	

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Appendix J
Fire Safety and Emergency Contingency Plan

FIRE SAFETY AND EMERGENCY CONTINGENCY PLAN

NORTHWIN LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA

Prepared For: **Upland Excavating Ltd.**
Northwin Landfill
7295 and 7311 Gold River Highway
Campbell River, British Columbia

JULY 13, 2020
REF. NO. 088877 (14) APPK

TABLE OF CONTENTS

LIST OF FIGURES

REVISIONS

DATE	REVISION NO.	AUTHOR/COMPANY	

1.0 INTRODUCTION

The operators of the Northwin Landfill, in compliance with British Columbia Occupational Health and Safety (B.C. OH&S) Regulation 296/97 Part 4, s.4.13-4.18 (Emergency Preparedness and Response) and Part 5, s.5.97-5.102 (Emergency Procedures) and Section 2.8 of the British Columbia Fire Code, have developed the following Fire Safety and Emergency Contingency Plan based on an assessment of the risks identified on-site. This plan documents the potential hazards and sets out the safety measures, roles, responsibilities, procedures, and parties to be contacted in the event of a medical or environmental emergency, or the occurrence of any of the identified hazardous situations.

The Northwin Landfill is located on an approximately 10 hectare parcel of land located in the City of Campbell River, British Columbia, within Lot A, District Lot 85, Plan 30709, Sayward District, approximately 10 km west of the city centre of Campbell River. The Site fronts onto Gold River Highway and is situated west of the Island Highway and south of McIvor Lake. The Northwin Landfill is owned by Upland Excavating Ltd. and operated by Northwin Environmental.

The Northwin Landfill is being developed and operated under Operational Certificate 107689.
The Landfill is authorized to accept demolition waste, construction waste, landfill clearing waste, soil meeting applicable British Columbia Contaminated Sites Regulation (CSR) industrial land use Standards, sludge from Landfill leachate or water management works, asbestos containing materials (in accordance with Section 40 of the HWR), and other wastes as authorized in writing by the director.

The following sections detail the Fire Safety and Emergency Contingency Plan for waste disposal operations at the Northwin Landfill. It is essential that site personnel be prepared in the event of an emergency. Emergencies can take many forms. The potential health and safety concerns identified in this plan include illnesses or injuries, chemical exposure, fires, explosions, spills, leaks, releases of harmful contaminants, or sudden changes in the weather. The following sections outline the general procedures for dealing with emergency situations that may potentially be experienced at the Northwin Landfill

This Plan will be reviewed by all on-Site personnel and kept at the Northwin Landfill. Emergency information presented herein, will be posted at the Site in locations where it can readily be seen. This Plan will be reviewed at least once annually by the owner/operator of the landfill, in consultation with the employee health and safety representative, to ensure that it remains effective and accurate as a Fire Safety and Emergency Contingency Plan.

2.0 EMERGENCY CONTACTS

This page is to be posted with the hospital road map in conspicuous workplace locations.

Fire:	911
Police:	911
Ambulance:	911
Poison Control Center:	1-800-567-8911
Hospital:	250-850-2141
	Campbell River Hospital
	375 2nd Ave.
	Campbell River, BC
	V9W 3V1

Directions to Campbell River Hospital (see Figure 2.1):

- Head northeast on Gold River Hwy/BC-28 E toward Argonaut Rd
- Turn right onto Inland Island Hwy/BC-19 S (signs for Nanaimo)
- Turn left onto 14 Ave
- Continue onto Homewood Road
- Continue onto 9 Ave
- Slight right onto Alder St
- Turn right onto 2 Ave, Destination will be on the left

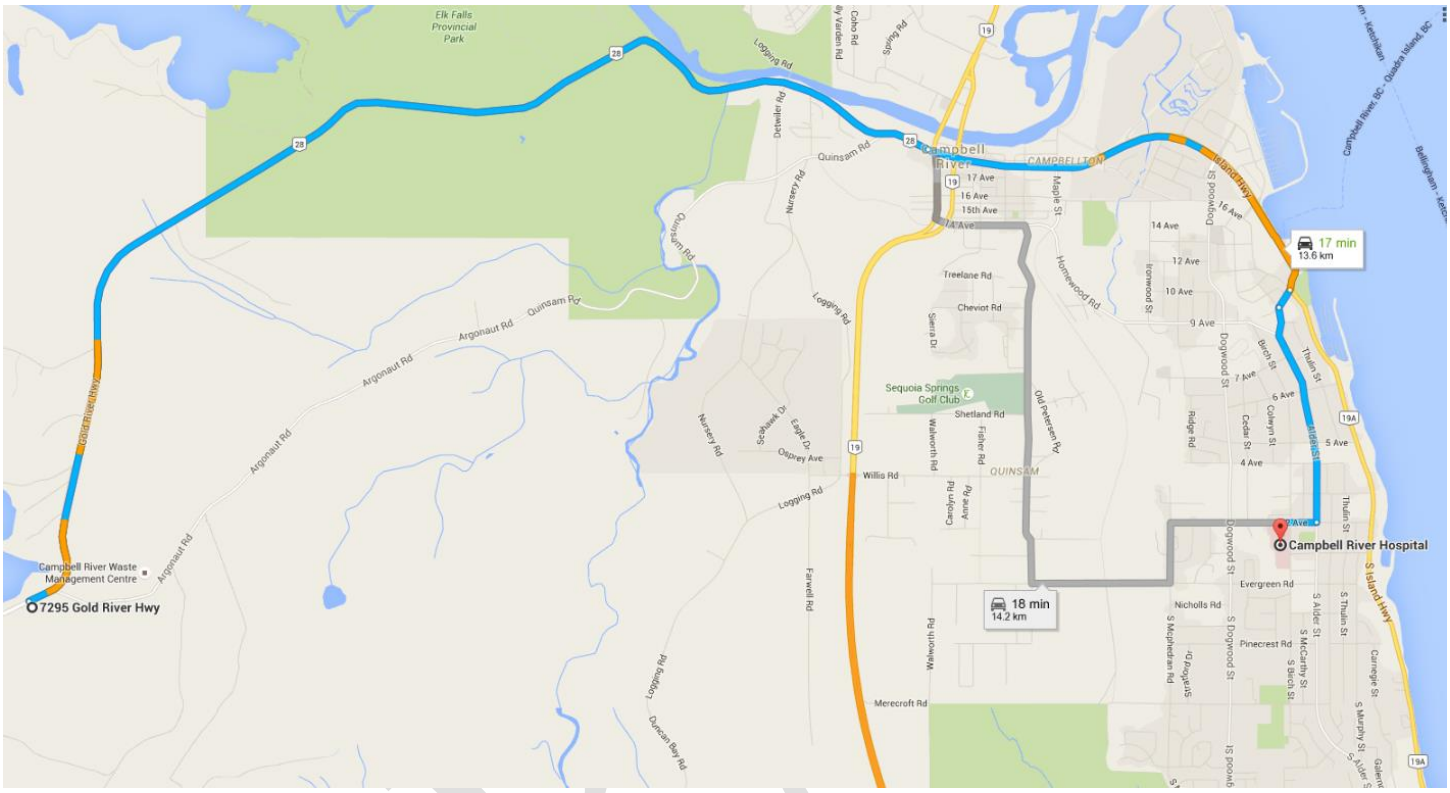
Provincial Emergency Program (PEP), 24 hour Spill Reporting:	1-800-663-3456
ENV Regional Waste Manager (Allan Leuschen)	250-751-3199
Ministry of Forest, Lands and Natural Resources	250-286-9300
Fire Department	250-286-6266
Forest Fire Reporting	1-800-633-5555
	*5555 Cellular

Upland Excavating Ltd. (Northwin Landfill Operator)

- Site Manager (Brian Fagan) 250-202-8644 (Cell)
- Site Manager (Terry Stuart) 250-287-5910 (Cell)

FIGURE 2.1
EMERGENCY HOSPITAL ROUTE

TO BE POSTED IN CONSPICUOUS AREAS OF THE WORKPLACE



Map Data/Image Source: Google Maps, 2016

Hospital: 250-850-2141
Campbell River Hospital
375 2nd Ave.
Campbell River, BC
V9W 3V1

Directions to Campbell River Hospital (see Figure 2.1):

- Head northeast on Gold River Hwy/BC-28 E toward Argonaut Rd
- Turn right onto Inland Island Hwy/BC-19 S (signs for Nanaimo)
- Turn left onto 14 Ave
- Continue onto Homewood Road
- Continue onto 9 Ave
- Slight right onto Alder St
- Turn right onto 2 Ave, Destination will be on the left

3.0 EMERGENCY EQUIPMENT AVAILABLE ON SITE

The following emergency equipment is available at the Front Desk of the Site Office:

- First aid kit (Level 1 Kit)
- 20 pound Class A, B, and C dry chemical fire extinguisher
- Petroleum spill containment kit
- Telephone
- Portable air horn alarm

All Site vehicles and equipment, including excavators, loaders, rock-trucks, and pick-up trucks, are all equipped with Class A, B, and C dry chemical fire extinguishers.

A suitable pump with appropriate length of hose will be kept available on-site at all times to pump water from the wash plant pond for emergency use.

4.0 EMERGENCY ROUTES AND ASSEMBLY POINTS

The Northwin Landfill Operator will ensure that emergency exit routes and assembly points are marked on Site by clear signage and in accordance with municipal and provincial requirements.

5.0 MEDICAL EMERGENCIES

The Northwin Landfill Operator will employ, and assign to the Site, a competent and authorized representative, herein referred to as the HSO. A Site Health & Safety Representative will also be selected. The Site Supervisor will be present at the Northwin Landfill during normal operating hours.

The Northwin Landfill Operator will ensure that all on-Site personnel, as a minimum, are equipped with the appropriate first aid materials and supplies and personnel protective equipment (PPE), and clothing required by municipal and provincial regulations. Safety and emergency equipment and PPE and clothing will be stored in a readily accessible location when not in use and kept clean and well maintained. The location of the equipment will be marked by clear signage.

Emergency and first-aid equipment will be placed at or near the active work area of the Northwin Landfill during normal operating hours. A list of the emergency and first aid equipment available at the Site and where this equipment is located is provided in Section 3.0 of this Plan.

As a minimum, the Northwin Landfill Operator will designate at least one person who is trained in basic first aid and CPR as the First Aid Attendant, to be on-Site at all times. This person may perform other duties, but will be immediately available to render first aid when required.

In the event of injury requiring immediate first-aid / medical attention to on-Site personnel, the following procedures will be implemented:

- Notify the First Aid Attendant and administer initial first aid services
- Notify the HSO/Site Supervisor
- Phone the hospital and/or medical service provider closest to the Northwin Landfill (see Section 2.0) and describe the nature of the injury or event
- As directed by the hospital, administer additional on-going first aid or CPR
- As directed by the hospital, either wait for an ambulance to arrive or transport personnel to the specified hospital along the most direct route
- If the injured person will be transported by ambulance and it is safe to leave them (when only two workers are on Site) meet the ambulance at the gate and direct them to the injured person, otherwise, give the ambulance/hospital complete and accurate directions to your exact location at the Site

Note: Any person transporting an injured/exposed person to the designated hospital for treatment, should take directions to the hospital with them (Figure 2.1). Details of the injury and a list of the compounds of concern, animal or insect bites, or other injurious circumstances to which the worker may have been exposed should also accompany the injured person.

6.0 FIRE OR EXPLOSION

All fire fighting equipment present at the Site shall be regularly inspected (monthly minimum) and maintained in accordance with manufacturer's recommendation and a record of these inspections will be kept on Site.

In the event of an uncontrolled fire, explosion, release of hazardous material, or the need for emergency evacuation, the following procedures will be followed:

- Notify all workers on Site by sounding the air horn alarm
- Site personnel will report immediately to the upwind safe assembly area and the Site Supervisor will confirm the safe evacuation of all workers from the hazardous area
- Notify the Fire Department / emergency services immediately
- Notify the HSO
- Notify any adjacent workplaces or residences which may be affected by exposure (**Note:** notification of the public must be in conformity with the requirements of municipal and provincial agencies (BC Reg. 296/97, s.5.100))
- Site personnel will position themselves at the entrance gate and such other safe locations as to effectively direct the Fire Department to the location of the uncontrolled fire or hazardous circumstances
- Site personnel will advise the Fire Commander of the location, nature, and identification of any hazardous materials at the Site as per the Inventory of Hazardous Substances maintained at the Site (see Section 10.0)
- If the Site Supervisor determines that it is safe to do so, before the Fire Department arrives, site personnel may:
    - Use fire equipment available on Site
    - Remove or isolate flammable or other hazardous materials that may contribute to the fire
- If the Fire Commander determines that it is safe to do so, Site personnel may assist the Fire Department

7.0 SPILLS OR LEAKS

The Northwin Landfill operator will ensure that all on-Site personnel have received the appropriate Work Place Hazardous Materials Information System (WHMIS) training as required by provincial regulations. The Northwin Landfill operator will ensure that personnel assigned to spill clean-up and re-entry duties have been trained in the safe procedures and use of personal protective equipment appropriate to the spill conditions. Written procedures for clean up and record of training will be maintained on Site. The Northwin Landfill operator will ensure that PPE and related clean-up equipment is readily available on Site and maintained in good condition.

In the event of a spill or leak, site personnel will follow the following procedures:

- Notify the Site Supervisor and/or HSO of the accidental release
- Report off-Site spills and releases of hydrocarbon contaminated soils or contaminated water to PEP and the B.C. Ministry of Environment and Climate Change Strategy in accordance with the B.C. Spill Reporting Regulation
    - **B.C. Emergency Management: 800-663-3456**
- Locate the source of the spillage, determine the degree of hazard associated with the clean-up activities, and if it can be done safely, stop the flow or release of the contaminant
- Contain and recover the spilled materials, in a safe manner as appropriate

Where volumes of spilled or leaked material exceed those specified in the BC Spill Reporting Regulation (B.C. Reg. 187/2017) (Attached as Table 1) a report shall be made to PEP including the following information. Reportable limits should be confirmed at least annually during the revision of the report.

1) The reporting person's name and telephone number
2) The name and telephone number of the person who caused the spill
3) The location and time of the spill,
4) The type and quantity of the substance spilled,
5) The cause and effect of the spill,
6) Details of action taken or proposed to comply with section 3,
7) a description of the spill location and of the area surrounding the spill,
8) The details of further action contemplated or required,

9) The names of agencies on the scene, and

10) The names of other persons or agencies advised concerning the spill.

If the spill is not reportable, under the B.C. Spill Reporting Regulation a Notification of Independent Remediation Initiation form, Site Risk Classification Report Form, and Exposure Pathway Questionnaire is required and the independent remediation may be initiated.

If the spill is reportable, under the B.C. Spill Reporting Regulation, a B.C. Ministry of Environment case manager will be appointed to guide remediation requirements.

8.0 INCLEMENT WEATHER

The following special procedures will be implemented during periods of severe weather, such as high winds, rain, electrical storms, thermal inversions, and winter conditions.

High Winds

If winds become excessive, the following control measures will be implemented at the Northwin Landfill to ensure that dust and litter does not become problematic or hazardous:

- Low speed limits will be enforced
- All vehicle traffic transporting waste to and around the Northwin Landfill will be appropriately loaded to prevent debris from blowing out of the vehicle
- Landfilling activities will be reduced
- Soil handling operations will be suspended
- If dry conditions warrant, water (dust suppressant) will be applied to roadways and borrow areas, and if required, to the active disposal area
- Personnel will wear appropriate respiratory protection if total dust particulates exceed provincial exposure limits

Rain and Electrical Storms

Rain: is not expected to adversely affect operations; therefore the Northwin Landfill will be operated during all but extremely excessive rain periods. If access roads become impassable due to heavy rain, they will be graded and granular material will be added as necessary to maintain and improve operating conditions.

Electrical Storms: In the event of an electrical storm, all operations will be suspended until the storm subsides and personnel will take safe shelter in the Site Office. All electrical powered equipment will be immediately shut down in a manner that will not endanger personnel.

Winter Conditions

During winter operations, the Northwin Landfill Operator will undertake advanced planning for site preparation/access, snow removal, and the stockpiling and storage of waste cover material.

The following procedures will be taken during winter weather conditions:

- The Northwin Landfill operator will ensure that all on-Site personnel are suitably clothed for working in winter conditions and monitor ongoing conditions to minimize the potential for cold related stress/hypothermia
- During severe winter conditions the HSO will provide appropriate direction to on-site personnel, regarding the continuance or curtailing of Northwin Landfill operations
- Site equipment will be cleaned and maintained on a daily basis to ensure safe operation during periods of cold or extreme weather
- Snow accumulation will be removed from the access roads and working areas prior to and during each day's landfilling activities, as required to maintain safe working conditions
- Frozen fill materials will not be placed in the landfill
- All runoff from snow, which has contacted waste or soil in the Landfill will be managed as leachate and controlled accordingly

9.0 EMERGENCY PROCEDURES TRAINING & DRILLS

The following training requirements will be followed as written in the B.C. OH&S Reg. 296/97 Part 4, s.4.16:

- All workers must be given adequate instruction in fire prevention and emergency evacuation procedures applicable to their workplace
- Workers assigned firefighting duties must be given adequate training by a qualified instructor in suppression methods, fire prevention, emergency procedures, company organization and chain of command, and firefighting crew safety and communications applicable to their workplace
- Retraining must occur once per year
- A worker not covered by B.C. OH&S Reg. 296/97 Part 31 (Firefighting), who is assigned firefighting duties, must be physically capable of performing the duties assigned safely and effectively, before being permitted to do them
- At least once per year, emergency drills must be conducted to ensure worker awareness and effectiveness of the exit routes and procedures
- A record of the drills is to be kept at the Site Office

10.0 HAZARDOUS SUBSTANCE INVENTORY & NOTIFICATION OF FIRE DEPARTMENT

The Northwin Landfill Operator will maintain a Hazardous Substance Inventory (Inventory) at the Site. The Inventory will include safe handling methods for all hazardous substances that are stored at the Site in quantities that may endanger workers in an emergency. The Inventory will include such materials as WHMIS controlled products, explosives, pesticides, radioactive materials, hazardous wastes, and will provide the nature, location, quantity and Material Safety Data Sheets (SDS) for the material.

As part of Site operations, the Northwin Landfill Operator performs visual inspections of all waste loads received at the Site and any material that is not authorized for discharge at the Site, including hazardous substances, is rejected by the operator and sent off Site for disposal. As such, the Inventory is limited to materials that are stored on Site for use by the Northwin Landfill only and not for landfilled materials.

The Inventory is to be kept up to date and located in an area readily accessible by personnel during an emergency. The Fire Department shall be notified of any significant changes to the Inventory.

Table 1

Reportable Limits for Spills and Releases
Fire and Emergency Contingency Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

Substance spilled[(1)]	**Specified amount**[(1)]
Explosives Class 1 as defined in section 2.9 of the Federal Regulations	50 kg, or less if the substance poses a danger to public safety
Flammable Gases Class 2.1 other than natural gas, as defined in section 2.14 (a) of the Federal Regulations	10 kg
Non-Flammable and Non-Toxic Gases Class 2.2 as defined in section 2.14 (b) of the Federal Regulations	10 kg
Toxic Gases Class 2.3 as defined in section 2.14 (c) of the Federal Regulations	5 kg
Flammable Liquids Class 3 as defined in section 2.18 of the Federal Regulations	100 L
Flammable Solids Class 4 as defined in section 2.20 of the Federal Regulations	25 kg
Oxidizing Substances Class 5.1 as defined in section 2.24 (a) of the Federal Regulations	50 kg or 50 L
Organic Peroxides Class 5.2 as defined in section 2.24 (b) of the Federal Regulations	1 kg or 1 L
Toxic Substances Class 6.1 as defined in section 2.27 (a) of the Federal Regulations	5 kg or 5 L
Infectious Substances Class 6.2 as defined in section 2.27 (b) of the Federal Regulations	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
Radioactive Materials Class 7 as defined in section 2.37 of the Federal Regulations	Any quantity that could pose a danger to public safety and an emission level greater than the emission level established in section 20 of the Packaging and Transport of Nuclear Substances Regulations, 2015 (Canada)
Corrosives Class 8 as defined in section 2.40 of the Federal Regulations	5 kg or 5 L
Miscellaneous Products, Class 9 Substances or Organisms as defined in section 2.43 of the Federal Regulations	25 kg or 25 L
Waste containing dioxin as defined in section 1 of the Hazardous Waste Regulation	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
Leachable toxic waste as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L
Waste containing polycyclic aromatic hydrocarbons as defined in section 1 of the hazardous Waste Regulation	5 kg or 5 L
Waste asbestos as defined in section 1 of the Hazardous Waste Regulation	50 kg
Waste oil as defined in section 1 of the Hazardous Waste Regulation	100 L
Waste containing a pest control product as defined in section 1 of the Hazardous Waste Regulation	5 kg or 5 L
PCB Wastes as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L
Waste containing tetrachloroethylene as defined in section 1 of the Hazardous Waste Regulation	50 kg or 50 L
Biomedical waste as defined in section 1 of the Hazardous Waste Regulation	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
A hazardous waste as defined in section 1 of the Hazardous Waste Regulation and not covered under items 1 to 22	25 kg or 25 L
A substance, not covered by items 1 to 23, that can cause pollution	200 kg or 200 L
Natural gas	10 kg

NOTES:
(1) Substance definitions and reportable spill amounts from BC Spill Reporting Regulation (B.C. Reg. 187/2017 including amendments upto B.C. Reg 221/2017, December 5,2017) current to July 7, 2020

Federal Regulations: The Transportation of Dangerous Goods Regulations made under the *Transportation of Dangerous Goods Act* (Canada)
Hazardous Waste Regulation: B.C. Reg. 63/88.

Appendix K
Trigger Level Assessment Program

Appendix K Trigger Level Assessment Program

The following Site-specific tiered Trigger Level Assessment Program (TLAP) has been developed for the Upland Landfill. The TLAP follows a three-tiered approach to monitor and assess primary liner leakage rates and potential groundwater quality impacts associated with Landfill activities. The TLAP will trigger the timely implementation of contingency measures related to liner leakage or water quality alterations, if needed.

The trigger level monitoring locations include:

- Landfill leak detection system
- Aeration pond leak detection system
- Aeration pond point of discharge
- Future monitoring well MW13 located adjacent to and downgradient of the aeration pond
- Future monitoring well MW12 located downgradient of the landfill and adjacent to the south property boundary
- Existing monitoring well MW10-17 located at the downgradient south property boundary
- Future monitoring well MW11 located at the downgradient east property boundary

1. Trigger: Primary Liner Leakage Rate

1.1 Tier I – Routine Leakage Rate Monitoring

The Tier I TLAP includes quarterly monitoring of the Landfill and aeration pond leak detection systems. Lysimeters will be installed within the leak detection system(s) drainage layer to monitor for the presence of leakage from the primary liner of the landfill and/or aeration pond at various locations within the system. Leakage rate monitoring will be completed as part of the Environmental Monitoring Program (EMP) prepared for the Site. The EMP is described in Section 14 of the DOCP.

Leakage rate monitoring results will be assessed for the following triggers:

- Leakage rates at the landfill and/or aeration pond leak detection systems show an increasing trend toward 10.1 m^3 in one quarter. Trends will be assessed using statistical analysis such as Mann-Kendall and/or t-test.
- Leakage rate is at or above 10.1 m^3 per quarter during a single monitoring event.

The leakage rate of 10.1 m^3 per quarter represents 25 percent of the leakage associated with the complete geomembrane liner failure scenario. GHD modelled a leakage rate of 40 m^3 per quarter indicative of a complete failure or breach of the geomembrane (Scenario 3), as described in Section 13.3 of the DOCP.

If either trigger occurs, Tier II increased monitoring and primary liner performance investigation will be initiated.

1.2 Tier II – Increased Monitoring and Investigation

The Tier II TLAP includes two parts. The first part of Tier II includes monthly monitoring of the leak detection system(s) to confirm leakage monitoring results. If monitoring results confirm that leakage is occurring, a Tier II investigation will be initiated. The second part of Tier II is an investigation using dedicated lysimeters to determine where the leakage is occurring within the detection system(s). The Tier II investigation includes an assessment of the primary liner(s) to determine where leakage is occurring and the ability to expose the liner for repair.

The completion of the Tier II investigation triggers the Tier III contingency measures and confirmatory monitoring.

1.3 Tier III – Contingency Measures and Confirmatory Monitoring

The Tier III TLAP includes either:

- Repairing the primary liner or
- If the primary liner cannot be repaired due to the practicality in accessing the location, the leachate collection system will be operated under dry conditions to reduce leakage through the primary liner system and an intermediate/final cover deployment plan will be prepared.

The design of the cover deployment plan will be dependent on the stage of the Landfill's development and the location of the primary liner system leakage. The objective of the plan is to proceed with early deployment of intermediate and/or final cover. Confirmatory leakage rate monitoring will continue on a monthly basis until steady state conditions are again achieved.

2. Trigger: Water Quality

2.1 Tier I – Routine Water Quality Monitoring

The Tier I TLAP includes quarterly groundwater quality monitoring at existing monitoring well MW10-17 and future monitoring wells MW11, MW12, and MW13. Water quality monitoring will be completed as part of the EMP prepared for the Site. The EMP is described in Section 14 of the DOCP. Groundwater samples will be analyzed for field parameters, general chemistry, nutrients, LEPH/HEPH, and CSR metals.

The water quality monitoring results for MW10-17, MW11, MW12, and MW13 will be assessed for the following triggers:

- At two or more TLAP monitoring locations, leachate indicator concentrations show an increasing trend toward half of the applicable CSR DW Standard. Increasing trends will be assessed using statistical analysis such as Mann-Kendall and/or t-test; or
- During a single monitoring event, concentrations of two or more leachate indicator parameters at a single TLAP monitoring location meet or exceed half of the applicable CSR DW Standard.

If either trigger occurs, Tier II confirmatory sampling will be initiated.

2.2 Tier II – Confirmatory Sampling and Investigation

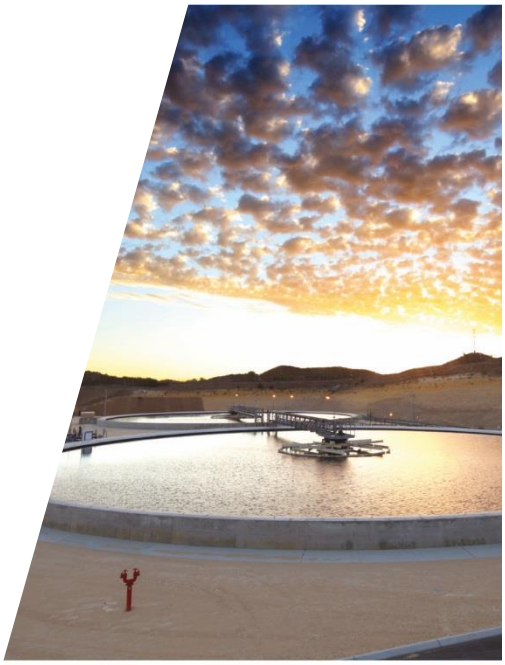
The Tier II confirmatory sampling will consist of resampling the triggered monitoring location(s) under increased frequency (e.g. monthly). If confirmatory sampling results confirm that Landfill water quality impairments are present, as defined under Tier I trigger levels, an investigation will be triggered. The investigation will assess the degree, nature, and potential source(s) of the trigger level exceedance. Increased sampling frequency will continue at the appropriate location(s) during the investigation.

The results of the Tier II investigation will assist in determining the most suitable water quality contingency measure as outlined in the Contingency Plan developed for the Landfill. The implementation of the contingency measure should stabilize or reduce the Landfill-derived water quality impairments at the appropriate location(s). Should the Tier II investigation confirm increasing concentrations above the trigger levels, Tier III contingency measures and compliance monitoring will be initiated.

2.3 Tier III – Implementation of Contingency Measure(s) and Compliance Monitoring

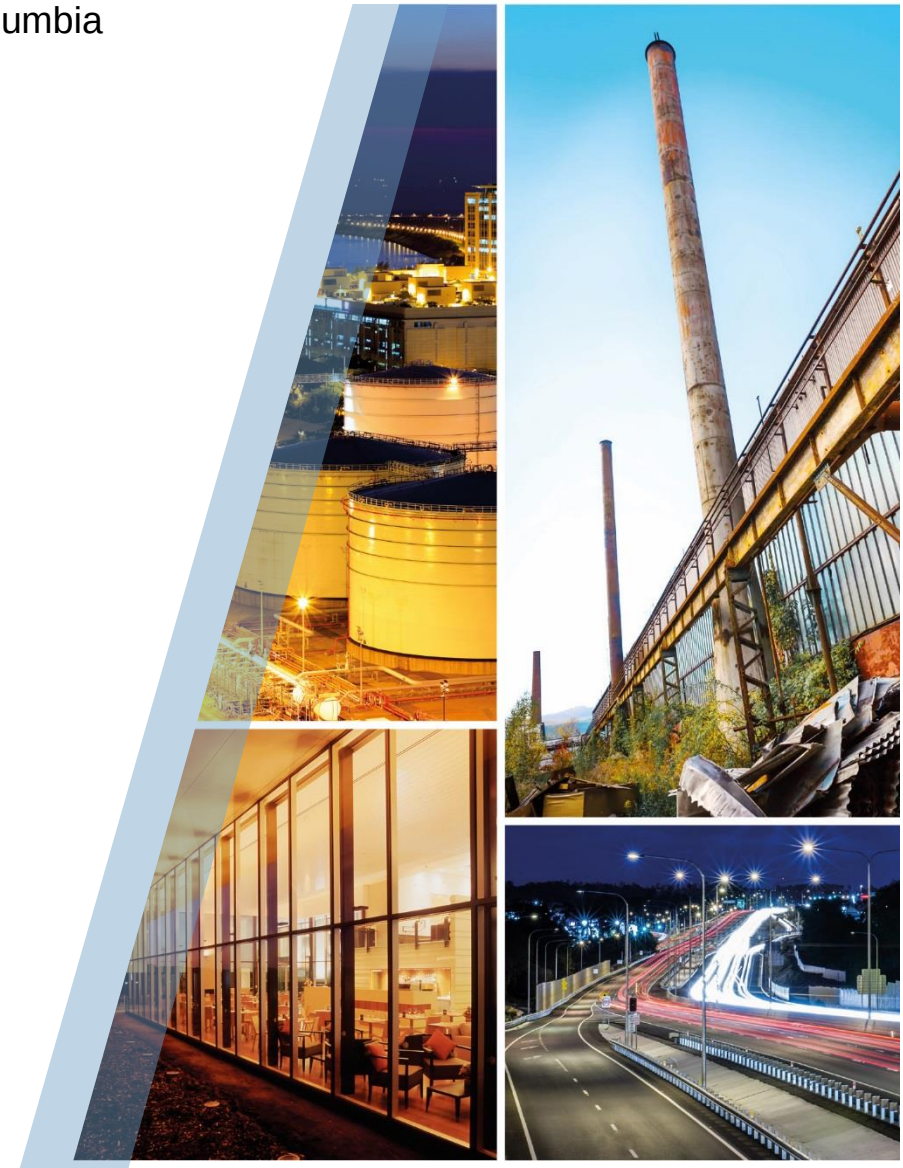
The Tier III TLAP includes the development of an implementation plan for the water quality contingency measures identified under Tier II, the deployment of the water quality contingency measures, and compliance monitoring. Following approval of the plan and implementation of the contingency measures, compliance monitoring will begin at monitoring wells MW10-17, MW11, MW12, and MW13. The purpose of the compliance monitoring will be to assess and evaluate the effectiveness of the contingency measure(s) implemented. A specific compliance monitoring program cannot be detailed in the TLAP as the extent and type of future groundwater quality impacts, if any, are unknown.

Appendix L
Financial Security Plan



Financial Security Plan

Upland Landfill
Campbell River, British Columbia



Upland Excavating Ltd.

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Table Index

Table Index (Following Text)

1. Introduction

This Financial Security (FS) Plan was prepared by GHD for the New Landfill, known as Northwin Landfill located on the Upland Pit Property (Site) in Campbell River, British Columbia. The FS Plan forms part of the 2021 Design, Operations and Closure Plan (DOCP), and was prepared based on the *"British Columbia Landfill Criteria for Municipal Solid Waste, Second Edition"* (BCMOE, June 2016), herein referred to as the *Landfill Criteria*.

FS is required for all private landfills in accordance with *Section 8.0 - Financial Security* of the Landfill Criteria. The amount of the financial security provided in each year must be adequate to fund the closure of the landfill in that year and fund post-closure operations, monitoring, and maintenance for the estimated contaminated lifespan.

Section 2.10 of the Operational Certificate Number: 107689 (OC) provides additional instruction for calculating the Financial Security. This FS satisfies Section 2.10(b), which states:

> *(b) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a financial security plan that includes:*
>
> *(i) the tasks, estimated costs, contingency costs, calculations of the amounts of financial security and time periods, to carry out and complete the plan referred to in section 2.9(a) of this operational certificate (plan to remove all waste from the Original Landfill),*
>
> *(ii) the calculations of the amounts of financial security and time periods for each phase of development for the New Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,*
>
> *(iii) the amounts of financial security for the corresponding time periods.*

2. Closure, Post-Closure and Contingency Activities Considered for the Security Funds Evaluation

2.1 Closure Costs

The closure costs consist of the estimated capital and engineering cost to install final cover on the Landfill in accordance with DOCP. The final cover design consists of a low permeability ($<1x10^{-7}$ cm/s), barrier layer including a geosynthetic clay liner, 0.6 metre (m) sand cover and a 0.15 m vegetated topsoil layer.

The activities considered in the closure costs to estimate the security fund are:

- Compaction and grading of the landfill surface
- Final cover placement and hydroseeding
- Installation of fences and surface water control works
- Installation of landfill gas collection (LFG) vents

2.2 Post-Closure Costs

The post-closure costs consist of the Site monitoring, operation, and maintenance cost during the post-closure stage in accordance with the DOCP. Activities considered in the post-closure cost estimation include:

- Administration
- Site maintenance including road maintenance/repair, vegetation management, erosion/surface water repairs
- Leachate treatment (on-Site or off-Site)
- Water quality monitoring
- Consultation and reporting

2.3 Costs of Contingency Measure Implementation

Section 16 – Contingency Plan of the DOCP outlines the possible contingency measures or actions that will be taken to address potential failure or non-compliance of the Landfill performance criteria. The activities considered in the financial security contingency cost estimation are those not encompassed in the post-closure costs described in Section 2.2 above, and include:

- Modifications/upgrades to the leachate treatment system
- Replacement/repair of the aeration pond base liner

2.4 Financial Contingency

In accordance with *Section 8.2 – Calculating Financial Security* of the Landfill Criteria, the amount of financial security shall include a contingency of 20 percent of the sum of the closure costs, post-closure costs and the contingency measures cost.

3. Site Operating Parameters

The following Site operating parameters were taken into consideration to establish the closure and post-closure cost estimates:

- Projected rate of fill and landfill lifespan
- Leachate generation rates, landfill gas generation rates, and contaminating lifespan of the landfill with respect to groundwater, surface water, and landfill gas

3.1 Site Capacity and Estimated Site Life

As discussed in the DOCP, the total Site capacity is estimated to be 532,365 cubic metres. The Site life has been estimated based on the maximum annual fill rate of 45,000 tonnes per year. Waste from the Original Landfill to the New Landfill does not contribute to the maximum allowable fill rate. Using a waste density of 1.3 tonnes per cubic metre, the annual airspace consumption is approximately 34,615 cubic metres (except in the year when approximately 71,722 cubic metres of waste will be relocated from the Original Landfill). The Site life is a function of refuse density and

refuse quantities received, and will also be influenced by market conditions in British Columbia. The estimated Site life is 13.3 years, based on the forecasted fill rate.

A summary of the landfill and financial inputs is presented in Table 3.1.

3.2 Contaminating Lifespan

The contaminating lifespan of a landfill is the time required for the leachate concentrations to decrease by a combination of biological decomposition of the organics, physiochemical processes which reduce the solubility of inorganics, dissolution, adsorption, or complexation and dilution by infiltration, to regulatory defined surface water quality objectives (i.e., Contaminated Sites Regulation Water Quality Standards). Post-closure care funding have been estimated for the duration of the contaminating lifespan of the Site, following closure of the Site, to ensure that adequate funds are available to mitigate any potential environmental impacts.

As discussed in the DOCP, it is anticipated that leachate generated from the Site will reduce to concentrations below regulatory levels or Site-specific trigger levels in approximately 28 years from time of closure. This is less than the minimum 30-years specified in *Section 8.3 – Post-Closure Period* of the Landfill Criteria. As such, the post-closure period for the purposes of estimating the amount of financial security required is 30 years.

4. Discount and Inflation Rates

All cost estimates for the financial security are presented in net present values (2021) and adjusted for inflation and discount rates. The discount and inflation rates used for the cost projection were selected based on *Section 8.4 – Cost To Be Presented In Current Dollars* of the Landfill Criteria, which states the following:

All cost estimates should be presented in net present values and adjusted for inflation and discount rates. Inflation rates shall be based on the British Columbia Consumer Price Index averaged over the preceding 10-year period or as recommended by a qualified professional. Discount rates shall be based on the current Government of Canada Long Term Bond Yield or as recommended by a qualified professional.

4.1 Discount Rate

Due to fluctuations in Canadian bond yields in recent years, the discount rate was selected to be the 10-year average Government of Canada benchmark bond yields: long term, as published in the Bank of Canada website: http://www.bankofcanada.ca/rates/interest-rates/lookup-bond-yields/. The Government of Canada 10-year average benchmark bond yields: long term, for the period between 2012 and 2021 is 3.15 percent as presented in Table 3.1.

4.2 Inflation Rate

The inflation rate applied to forecast construction costs, is calculated based on 10-year average monthly % change in Consumer Price Index (CPI) for British Columbia. Statistics Canada, 18-10-0004-01, Data Visualization: 71-607-X2018016, last accessed June 26, 2021. The 10-year average inflation rate for the period between 2011 and 2021 is 1.53 percent as presented in Table 3.1.

5. Cost Estimation Results

Closure, post-closure and contingency costs have been developed based on present day estimates of the cost to complete the activities discussed in Section 2. The present day (year of this report) cost estimates are provided in Table 5.1.

5.1 Closure Costs

As discussed in the DOCP, the Landfill will be developed in three phases and progressively closed throughout the lifespan of the Landfill. The planned closure costs are estimated based on the closure schedule presented in the DOCP Fill Plan, whereas emergency closure costs are based on the cost to close the remaining open landfill footprint area in a given year.

In Phase 1 a total of 27,440 m^2 of lined landfill footprint will be constructed over the four year period. During year one of Phase 1 East only 13,763 m^2 is filled, therefore, the area that could potentially require final cover in that year is 13,763 m^2. In Phase 1 West, 3,720 m^2 of side slopes will be closed. In Phase 2A, the landfill footprint is expanded to 33,471 m^2, however, 9,050 m^2 of area is closed with final cover. In this Phase, 24,421 m^2 could potentially require final cover under an emergency closure scenario.

In Phase 3A, the total footprint is expanded to the maximum size of 36,683 m^2 with 27,633 m^2 remaining open. In Phase 3B, an area of 7,185 m^2 is closed. In both Phase 3B and 3C, the area potentially requiring emergency closure is 16,235 m^2.

Progressive planned closure is scheduled for 2024, 2029 and 2033, and final closure is planned for 2035.

Table 5.2 presents the financial security calculations, including the planned and emergency closure costs based on the area requiring to be closed. The cost of emergency closure is higher than planned closure in each year, except in the year of final landfill closure.

5.2 Post-Closure Costs

Post-closure cost estimates are based on information supplied by Upland Excavating Ltd. and engineer's estimates. During Landfill operations leachate management will consist of on-Site treatment with discharge an infiltration pond, and this method was planned to continue 3 years of post-closure. After 3 years of post-closure, it is anticipated that the volume of leachate generated will be very low (less 2 m^3 per day on average or 573 m^3 per year), as such, the on-Site leachate treatment infrastructure will be decommissioned, and residual leachate will be managed by trucking for disposal off-Site. The calculation of leachate generation rates are presented in the DOCP.

As shown in Table 5.1, the estimated annual cost associated with post-closure activities will decrease over time as the Landfill nears the end of its contaminating lifespan (30 years). Post-closure costs will be highest in the first three years of post-closure. The monitoring and reporting effort are expected to be reduced three years after closure and further reduced after 7-years post-closure. General operations and maintenance requirements are also expected to reduce following a similar schedule.

The annual cost for the first 3 years is estimated to be $161,400 ($2021). The annual for the next three years after closure (years 4, 5 and 6) is estimated as $72,600 per year ($2021), and the annual cost between seven and 30 years after closure is estimated as $42,600 ($2021).

As presented in Table 5.2, the maximum present value sum of post-closure costs, associated with an emergency closure in 2022 is $1,414,695.

5.3 Contingency Costs

The estimated contingency costs for upgrading or modifying the leachate treatment system and repairing or replacing the aeration pond base liner are provided in Table 5.1. A total of $350,000 of contingency costs have been considered in the financial security calculation shown in Table 5.2.

5.4 Financial Contingency

A financial contingency of 20 percent has been applied to the closure and post-closure cost estimation, as introduced in Section 2.4. These costs are included on Table 5.1. Contingency measure costs (Section 5.3) are estimated conservatively and include a 20 percent contingency in the nominal value.

6. Cost to Carry-Out the Plan to Remove All Waste from the Original Landfill

The Plan to Remove All Waste from the Original Landfill is outlined in Section 6.3.3 of the DOCP. The Original Landfill is a historical landfill located in the southeastern corner of the Site. Authorization to discharge a maximum of 45,000 tonnes per year of waste to the Original Landfill is provided under the OC. Authorization to discharge waste to the Original Lined Cell ceases on the earlier of: (i) the date the Original Lined Cell is filled to capacity with grades not steeper than 3H:1V (33 percent), (ii) the date of commencement of waste discharge to the New Landfill.

The fill plan provided in the 2020 Annual Report estimates that the Original Landfill has 2.8 years of remaining capacity. The total capacity of the Landfill, including the lined and unlined portions is 74,746 m^3.

The estimated cost of carrying out the Plan to Remove All Waste from the Original Landfill is $4.63 per cubic metre of waste. The cost was calculated based on the Island Equipment Owners Association's suggested equipment rates for two Class 11 excavators, a Class 3 dozer and a 30 ton rock truck (a combined hourly rate of $925). Based on previous work carried out at the Site, this combination of equipment can move approximately 200 cubic metres of material per hour. A 20 percent contingency was carried, as presented in Table 5.1.

The financial security for the Original Landfill is required until the Plan to Remove All Waste is carried out and a report certified by a Qualified Professional confirming such is submitted to the director, satisfying OC Section 2.9(d):

> *If the plan referred to in section 2.9(a) of this operational certificate is carried out, the operational certificate holder must cause a Qualified Professional to certify and submit a report to the director that confirms that the plan has been carried out and completed in accordance with the director's requirements, describes the plan implementation, describes and provides the waste categorization, describes and provides the sampling and results, describes the decommissioning of the Original Landfill and the Original Leachate Management Works, provides photos documenting the implementation of the plan referred to in section 2.9(a) of this operational certificate, and lists the tonnages or volumes, and categories of waste removed and discharged to the New Landfill and to other identified and authorized waste management facility(ies), on or before 60-days after the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed.*

7. Financial Security Plan Summary

Table 7.1 below presents the amount of financial security required each year of the first five years of operating life of the New Landfill. The maximum amount of security will be required during year four of operations, which corresponds to the maximum open landfill area that would require closure. The financial security amount is calculated in accordance with *Section 8* of the Landfill Criteria and is presented in 2021 Canadian dollars.

In addition, the financial security required for the Original Landfill for each year of the same first five-year period is also presented in Table 7.1.

The total financial security for the Site is calculated to satisfy Section 2.10(d) of the OC:

> *The amount of financial security at any time must be equal to or greater than:*
>
> *(i) Before the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the greater amount specified for the corresponding time period in:*
>
> - *the financial security plan in the most recent OCP,*
>
> - *the financial security plan in the most recent DOCP.*
>
> *(ii) On and after the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the amount specified for the corresponding time period in the financial security plan in the most recent DOCP.*

On or after the report referred to in Section 2.9(d) is submitted the financial security associated with the Original Landfill will be zero, and only the New Landfill financial security will be required.

Table 7.1 Financial Security – 5 Years

Year (Operating year)	New Landfill Financial Security Required	Original Landfill Financial Security Required
2022 (Year 1)	$2,049,079.57	$408,757.68
2023 (Year 2)	$2,111,347.94	$402,324.82
2024 (Year 3)	$2,095,240.57	$395,993.19
2025 (Year 4)	$2,274,959.57	$389,761.21
2026 (Year 5)	$2,239,157.17	$383,627.31

All of Which is Respectfully Submitted,

GHD

Roxanne Hasior, P.Eng.

Deacon Liddy, P.Eng., MBA

Tables

Financial and Landfill Input Data
Financial Security Plan
Northwin Landfill
Campbell River, British Columbia

Financial

Inflation rate (1)	1.53%
Discount rate (2)	3.15%

Northwin Landfill

Year	Forecasted Average Annual Waste Disposal Rate (Tonne)	Forecasted Cumulative Waste Disposed (tonnes)	Forecasted Average Annual Airspace Consumption (m^3) (3)	Forecasted Cumulative Airspace Consumption (m^3)
2022	138,238	138,238	106,337	106,337
2023	45,000	183,238	34,615	140,952
2024	45,000	228,238	34,615	175,568
2025	45,000	273,238	34,615	210,183
2026	45,000	318,238	34,615	244,799
2027	45,000	363,238	34,615	279,414
2028	45,000	408,238	34,615	314,029
2029	45,000	453,238	34,615	348,645
2030	45,000	498,238	34,615	383,260
2031	45,000	543,238	34,615	417,875
2032	45,000	588,238	34,615	452,491
2033	45,000	633,238	34,615	487,106
2034	45,000	678,238	34,615	521,722
2035	13,836	692,075	10,643	532,365
Total	**678,238**		**521,722**	

Original Landfill

Capacity of Unlined Portion of Original Landfill (m3)	35,000
Waste-In-Place Unlined Portion of Original Landfill (m3)	35,000
Capacity of Lined Cell of Original Landfill (m3)	39,746
Waste-In-Place in Lined Cell of Original Landfill (as of Dec 31, 2020) (m3)	17,703
Total Capacity of Original Landfill (m3)	74,746
Total Waste-In-Place in Original Landfill (as of Dec 31, 2019) (m3)	52,703

Notes:

(1) 'The inflation rate applied to forecast construction costs, calculated based on 10-year average monthly % change in Consumer Price Index (CPI) for British Columbia. Statistics Canada, 18-10-0004-01, Data Visualization: 71-607-X2018016, last accessed June 26, 2021

(2) Discount rate calculated based on 10 year average Government of Canada Benchmark Bond Yields - Long Term. Bank of Canada, http://www.bankofcanada.ca/rates/interest-rates/lookup-bond-yields/, last accessed June 23, 2021

(3) Apparent Density of the waste = 1.3 tonnes per cubic metre

Closure, Post-Closure and Contingency Cost Estimates
Financial Security Plan
Northwin Landfill
Campbell River, British Columbia

Closure Cost Estimate			
Description	**Unit**	**Price per Unit**	**Price per m^2**
Sand (Available on-site)	m^3	$ 3.00	$ 2.25
GCL	m^2	$ 12.00	$ 12.00
Topsoil	m^3	$ 4.00	$ 0.60
Hydroseeding	m^2	$ 1.00	$ 1.00
LFG Vents	L.S.	$ 25,000.00	$ 0.69
Swales and Erosion Control	lin. m	$ 80.00	$ 1.29
Contingency (20%)			$ 3.57
Total			**$21.40**

Post-Closure Costs			
Description	**Annual Cost in the Years Post-Closure**		
	1 to 3	**4 to 6**	**7 to 30**
Administration	$ 2,500.00	$ 2,500.00	$ 2,500.00
Access Road Maintenance/Repair	$ 2,000.00	$ 2,000.00	$ 2,000.00
Vegetation Maintenance	$ 5,000.00	$ 3,000.00	$ 3,000.00
Erosion/Surface Water Repair	$ 5,000.00	$ 3,000.00	$ 3,000.00
Leachate Management System O&M	$ 60,000.00	$ -	$ -
Allowance for Off-Site Disposal of Residual Leachate	$ -	$ 10,000.00	$ 5,000.00
Groundwater/Leachate Monitoring	$ 48,000.00	$ 30,000.00	$ 15,000.00
Consultants (Reporting)	$ 12,000.00	$ 10,000.00	$ 5,000.00
Contingency (20%)	$ 26,900.00	$ 12,100.00	$ 7,100.00
Total	**$ 161,400.00**	**$ 72,600.00**	**$ 42,600.00**

Cost of Implementing Contingency Measures	
Contingencies	**Estimated Cost**
Leachate treatment system modifications	$ 300,000.00
Allowance for aerated equalization pond liner repairs	$ 50,000.00
Total	**$ 350,000.00**

Cost of Removal of All Waste from Original Landfill		
Description	**Unit**	**Price**
Equipment Cost	m^3	$ 4.63
Cost of Removal of All Waste from Original Landfill	-	$ 346,073.98
Contingency (20%)	-	$ 69,214.80
Total		$ 415,293.41

Table 5.2

Financial Security Calculation
Financial Security Plan
Northwin Landfill
Campbell River, British Columbia

Year	Year of Operation	Stage	Lined Area m^2	Open Area m^2	Scheduled Closure m^2	Closed Area m2	A Cost of Planned Closure Cash Flow	A Cost of Planned Closure with inflation	A Cost of Planned Closure (PV)	B Cost of Emergency Closure Cash Flow	B Cost of Emergency Closure with inflation	B Cost of Emergency Closure (PV)	C Sum of 30 Years Post-Closure O&M Costs (PV)	D Cost of Implementing Contingency Measures (PV)	Amount of FS Required for New Landfill (PV) = (MAX A or B) + C + D	Amount FS Required to Carry out Plan to Remove All Waste from Original Landfill* (PV)	Total FS* (PV)
2021																	
2022	1	1 East	13,763	13,763	0	0	$ -	$ -	$ -	$ 294,528.20	$ 299,024.66	$ 289,893.03	$ 1,414,694.69	$ 344,491.84	**$ 2,049,079.57**	**$ 408,757.68**	**$ 2,457,837.25**
2023	2	1 West	18,322	18,322	0	0	$ -	$ -	$ -	$ 392,090.80	$ 404,154.02	$ 379,846.77	$ 1,392,430.80	$ 339,070.37	**$ 2,111,347.94**	**$ 402,324.82**	**$ 2,513,672.76**
2024	3	1 West	22,881	19,161	3,720	3,720	$ 79,608.00	$ 83,309.99	$ 75,908.32	$ 410,045.40	$ 429,113.65	$ 390,989.08	$ 1,370,517.28	$ 333,734.21	**$ 2,095,240.57**	**$ 395,993.19**	**$ 2,491,233.77**
2025	4	1 West/ 2 A	33,471	29,751	0	3,720	$ -	$ -	$ -	$ 636,671.40	$ 676,450.23	$ 597,528.91	$ 1,348,948.63	$ 328,482.04	**$ 2,274,959.57**	**$ 389,761.21**	**$ 2,664,720.79**
2026	5	2 A	33,471	29,751		3,720	$ -	$ -	$ -	$ 636,671.40	$ 686,777.37	$ 588,125.24	$ 1,327,719.41	$ 323,312.52	**$ 2,239,157.17**	**$ 383,627.31**	**$ 2,622,784.48**
2027	6	2 A	33,471	29,751	0	3,720	$ -	$ -	$ -	$ 636,671.40	$ 697,262.18	$ 578,869.56	$ 1,306,824.30	$ 318,224.36	**$ 2,203,918.22**	**$ 377,589.93**	**$ 2,581,508.15**
2028	7	2 A	33,471	29,751	0	3,720	$ -	$ -	$ -	$ 636,671.40	$ 707,907.05	$ 569,759.54	$ 1,286,258.02	$ 313,216.27	**$ 2,169,233.83**	**$ 371,647.57**	**$ 2,540,881.41**
2029	8	2 A/ 2 B	33,471	24,421	5,330	9,050	$ 114,062.00	$ 128,760.31	$ 100,468.09	$ 522,609.40	$ 589,954.12	$ 460,324.81	$ 1,266,015.41	$ 308,287.00	**$ 2,034,627.21**	**$ 365,798.73**	**$ 2,400,425.95**
2030	9	2 B/ 2 C	33,471	24,421	0	9,050	$ -	$ -	$ -	$ 522,609.40	$ 598,960.75	$ 453,080.40	$ 1,246,091.37	$ 303,435.30	**$ 2,002,607.07**	**$ 360,041.94**	**$ 2,362,649.01**
2031	10	3 A	36,683	27,633	0	9,050	$ -	$ -	$ -	$ 591,346.20	$ 688,086.58	$ 504,604.09	$ 1,226,480.88	$ 298,659.96	**$ 2,029,744.92**	**$ 354,375.74**	**$ 2,384,120.67**
2032	11	3 A	36,683	27,633	0	9,050	$ -	$ -	$ -	$ 591,346.20	$ 698,591.37	$ 496,662.83	$ 1,207,179.02	$ 293,959.77	**$ 1,997,801.61**	**$ 348,798.72**	**$ 2,346,600.33**
2033	12	3 A / 3 B	36,683	20,448	7,185	16,235	$ 153,759.00	$ 184,417.48	$ 127,107.53	$ 437,587.20	$ 524,839.05	$ 361,739.02	$ 1,188,180.92	$ 289,333.54	**$ 1,839,253.48**	**$ 343,309.47**	**$ 2,182,562.94**
2034	13	3 B / 3C	36,683	20,448	0	16,235	$ -	$ -	$ -	$ 437,587.20	$ 532,851.59	$ 356,046.11	$ 1,169,481.80	$ 284,780.13	**$ 1,810,308.04**	**$ 337,906.60**	**$ 2,148,214.64**
2035	14	3 C/ Closure	36,683	0	20,448	36,683	$ 437,587.20	$ 540,986.46	$ 350,442.80	$ -	$ -	$ -	$ 1,151,076.97	$ 280,298.37	**$ 1,781,818.14**	**$ 332,588.76**	**$ 2,114,406.90**
2035	N/A	Post-Closure	36,683	0	0	36,683	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,132,961.78	$ -	**$ 1,132,961.78**	**$ 332,588.76**	**$ 1,465,550.54**

Notes:

Costs in columns A, B, C and D are based on the cost estimates provided in Table 5.1 and discounted using the rates shown in Table 3.1.

All values are presented in 2021 Canadian dollars, unless otherwise specified.

*Amount FS Required for the Original Landfill will no longer be required once the Plan to Remove All Waste from Original Landfill is carried out (Section 2.9(a) of OC) and completion report is submitted by a Qualified Professional (Section 2.9(d)).

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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