

2017 Design, Operations, and Closure Plan

Campbell River Waste Management Centre
Comox Strathcona Waste Management

Comox Valley Regional District

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Glossary

2016 Annual Report	2016 Operations and Monitoring Report (GHD, 2017)
2016 EMP	2016 Environmental Program (GHD, 2016)
2017 DOCP	2017 Design, Operations and Closure Plan, Campbell River Waste Management Centre (GHD, 2017)
ACM	Asbestos Containing Materials
ADC	Alternative Daily Cover
a_{max}	Peak horizontal acceleration
AMSL	Above mean sea level
BC	British Columbia
BCAWQG	British Columbia Approved Water Quality Guidelines
BCBC	British Columbia Building Code
BGS	Below ground surface
C&D	Construction and demolition
C_0	Parameter concentration at time of sufficient degradation
C_A	Parameter concentration prior to landfilling
C_B	Parameter concentration at Site closure
CLS	Contaminating lifespan
COC	Constituent of concern
CRR	Cyclic Resistance Ratio
CRWMC	Campbell River Waste Management Centre
CSWM	Comox-Strathcona Waste Management
CSR	British Columbia Contaminated Sites Regulation, B.C. Reg. 375/96
CVRD	Comox Valley Regional District
CVWMC	Comox Valley Solid Waste Management System
Director	Director of waste management - BC Minister of Environment or as authorized in writing by the Minister
DOCP	Design Operations and Closure Plan
DW	Drinking Water
EMA	Environmental Management Act
EMP	Environmental Monitoring Plan
ENV	British Columbia Ministry of Environment and Climate Change Strategy
Environmental Monitoring Guidelines	Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, January 1996 (MOE, 1996)
FS	Factor of safety
GHD	GHD Limited
GSC	Geological Survey of Canada
H&S	Health and safety
ha	Hectare
HASP	Site Health and Safety Plan
HELP	Hydrologic Evaluation of Landfill Performance

HHW	Household hazardous waste
HWR	British Columbia Hazardous Waste Regulation, B.C. Reg. 63/88
I-4	Industrial four land zoning
kg	Kilogram
km	Kilometre
Landfill Footprint	The horizontal area permitted for landfilling of waste at the Campbell River Waste Management Centre.
Landfill Criteria	Landfill Criteria for Municipal Solid Waste, second edition (MOE, 2016)
Landfill	The Campbell River Waste Management Centre Landfill
Landfill Site	The Campbell River Waste Management Centre, which includes the Landfill footprint and adjacent buffer zones.
LEL	Lower explosive limit
LFG	Landfill Gas
LLDPE	Linear low-density polyethylene
LOB	Landfill Operations Basics
m	Metres
m^2	Square metre
m^3	Cubic metre
mm	Millimetre
MOE	British Columbia Ministry of Environment (Now referred to as Ministry of Environment and Climate Change Strategy)
MOLO	Manager of Landfill Operations
MSW	Municipal solid waste
NBCC	National Building Code of Canada
NRC	Natural Resources of Canada
OC	Operational Certificate MR-02401
PGA	Peak ground acceleration
PLC	Programmable logic controller
Ppm	Parts per million
QP	Qualified Professional
Site	Congruent with Landfill Site in the 2017 DOCP
SRD	Strathcona Regional District
SWMP	Solid Waste Management Plan
SWM Pond	Surface Water Management Pond
SWM Plan	Surface Water Management Plan
WPS	Waste Profile Sheet

1. Introduction

GHD was retained by Comox-Strathcona Waste Management (CSWM), a function of the Comox Valley Regional District (CVRD) and the Strathcona Regional District (SRD), to prepare the following Design, Operations, and Closure Plan (2017 DOCP) for the Campbell River Waste Management Centre (CRWMC or Site). This 2017 DOCP is provides an update for the development of the CRWMC leading to closure of the landfill at the CRWMC (Landfill) and establishment of a solid waste transfer facility. The 2017 DOCP has been prepared in general accordance with the British Columbia Ministry of Environment's (MOE) "Second Edition Landfill Criteria for Municipal Solid Waste", dated June 2016 (Landfill Criteria).

1.1 Site Location

The CRWMC is located on Crown Lands within the city limits of Campbell River, British Columbia (BC) at 6700 Argonaut Road approximately 7.5 kilometres (km) west of the city centre. The Gold River Highway (Highway 28) is located to the north and west of the Site. McIvor Lake is located on the opposite side of Gold River Highway. The Site is bounded to the south and south east by Argonaut Road.

The legal description for the southern half of the Site is Block C, together with that part of Block A, and that part of Block K, all part of District Lot 85, Sayward District. The Licence of Occupation No. V922305 for Block A, C and K is provided in Appendix A.

The legal description of the northern portion of the Site is Block J, all part of District Lot 85, Sayward District. Lease No. 103555 for Block J is provided in Appendix A.

A Site location plan is provided as Figure 1.1. A Site Plan is provided as Figure 1.2.

1.2 Site Background

Prior to waste disposal operations at the Site, the Site operated as an aggregate extraction facility. According to CH2MHILL's 2009 closure plan, the Site was subsequently used as an unregulated dump site prior to the 1970s. Waste burning took place at the Site as well as disposal of liquid wastes (EBA, 2014). The City of Campbell River took over Site operations in the mid 1970s until ownership was transferred to the CVRD in 1999 (EBA, 2014). A private contractor, Berry and Vale, has operated the Site under contract with the CVRD since 1996.

The Site's entrance facility, material recovery area and the Landfill are located on Block C. Block J is primarily utilized for extraction of sand and gravel for use as cover material for the Landfill. The updated surface water management plan includes the establishment of a surface water management pond (SWM Pond) within Block J.

According to the Solid Waste Management Plan (SWMP), discussed in Section 1.3.2, the Site was projected to reach its capacity in early 2012. A transfer station was constructed in 2011 to divert certain incoming waste streams to the Comox Valley Waste Management Centre (CVWMC), discussed in Section 1.3.2. In 2014, a mechanically stabilized earth wall (MSE wall) was constructed along the southeastern Site boundary with the aim of addressing slope re-grading

concerns and adding approximately five years of waste capacity. During the installation of the MSE wall a portion of the lower slope along Argonaut Road was closed with final cover consisting of a low permeability membrane and soil cover.

1.3 Site Layout

Site layout is presented on Drawing C-01. The Site occupies approximately 29.7 hectares (ha) and includes four land blocks:

- Block C (southern portion of the Site) –Site infrastructure located on Block C includes the Landfill, perimeter containment berms and wall, access roads, surface water management piping and ditching, and the Site entrance facility. The Site entrance facility includes Site gate, weigh scales, Site offices, waste drop-off building, material recovering area for recyclable materials, and a parking lot.
- Block J (northern portion of the Site) – predominantly undeveloped forested land and the soil borrow pit which is used to source granular fill for on-site uses. Block J is the proposed location of the SWM Pond discussed in the Section 8.0. The surface water discharge from the Site will be located at the eastern side of Block J approximately 300 metres (m) northeast of the corner of Block C. (discussed further in Section 6). Block J provides the northern buffer zone for the Landfill.
- Block A (West of Block C) – a small portion of Block A contains the western most toe of the Landfill.
- Block K (North of Block C, West of Block J) – a small portion of Block K contains the surface water ditch north of the Landfill.

The Site property lines have been updated to include the portions of Block A and K utilized by the CRWMC, as presented in the Licence No. V922305 provided in Appendix A.

1.4 Zoning and Adjacent Land Use

Block C and J, as described in Section 1.3, are zoned as Industrial Four (I-4) under the City of Campbell River Bylaw No. 3250, 2006 (last amended November 7, 2016). Block A and K are zoned Industrial Three (I-3). Zoning of lands adjacent to the Site include Industrial Zone I-3, Rural One (RU-1), and Rural Two (RU-2). A Site Area Zoning map is provided as Figure 1.3.

The industrial land uses adjacent to the Site include concrete manufacturing and gravel extraction to the west and gravel extraction pit to the south. The industrial properties to the west include an auto scrap yard, two construction waste landfills, a small lumber mill, an asphalt plant and a salt storage shed and a scrap metal yard.

Forested Crown lands are present to the north, east, and southeast of the Site.

Residential dwellings are located on the RU-2 zoned property located immediately northeast of the Site, and approximately 430 m from the Landfill Footprint. A single residence is present west of the Site the east side of Gold River Highway. Several residential dwellings are located on Lakeshore Residential (LS-R) located to the west along McIvor Lake. The nearest residential dwelling in the LS-R properties is approximately 480 m from the Site and the Landfill Footprint.

1.5 Regulatory Setting

1.5.1 Operational Certificate

The Site currently operates under OC MR-02401, dated December 2, 2003 (OC) issued by the MOE. The OC replaced the original permit issued in November 1973 and last amended in July 1992. It is anticipated that OC MR-02401 will be updated following the submission of this 2017 DOCP.

1.5.2 Solid Waste Management Plan

The CSWM provides solid waste management services for the CVRD and the SRD. The CSWM services and programs are supported by the regional Solid Waste Management Plan, dated December 2012. The SWMP is mandated by the provincial Environmental Management Act (EMA). The SWMP provides a guide for management of solid waste and recyclable materials within the CVRD and SRD. The SWMP was updated in 2012 and received approval from the MOE on May 23, 2013. A five-year effectiveness review of the SWMP is currently being carried out in order to analyze the SWMP's implementation and effectiveness.

The CRWMC currently serves as the primary MSW disposal site for approximately 43,000 people located in Campbell River and surrounding communities (Campbell River wasteshed). In accordance with the SWMP, the Landfill will continue to be used for the discharge of waste until reaching capacity. The Landfill is currently forecasted to reach capacity in 2023. At that time the Site will continue to operate as a solid waste transfer station. The transfer station will act as a waste collection point for the Campbell River wasteshed with collected MSW to be transported to the Comox Valley Waste Management Centre (CVWMC) located in Cumberland, BC, approximately 75 km south of the Site.

The SWMP long-term regional solid waste management strategy is to progressively close the landfills in the region and consolidate landfilling of residual waste at the CVWMC. The existing capacity at the CRWMC will be used prior to closure while the CSWM invests in the construction of lined cells, a leachate treatment facility, and landfill gas (LFG) collection system at the CVWMC to accommodate long-term regional landfill requirements.

1.5.3 Provincial Regulations and Guidelines

The following provincial regulations are applicable to the design, operations, and monitoring of municipal solid waste landfills in BC and have been considered in the preparation of the 2017 DOCP:

- Environmental Management Act
- Comox Strathcona Waste Management - 2012 Solid Waste Management Plan, December 2012
- Second Edition Landfill Criteria For Municipal Solid Waste, June 2016 (hereinafter referred to as "Landfill Criteria")
- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, January 1996 (hereinafter called the "Environmental Monitoring Guidelines")

- Landfill Gas Management Regulation
- A Compendium of Working Water Quality Guidelines for British Columbia
- Contaminated Sites Regulation
- Hazardous Waste Regulation
- Groundwater Protection Regulation

1.6 Objectives and Scope

The objectives of this 2017 DOCP is to provide updates regarding the Site development to final closure, the design of the Landfill closure and surface water management system, operational procedures for waste management until the final closure, and post-closure monitoring and maintenance of the Landfill. To achieve this objective the 2017 DOCP includes updates to:

- The Site boundaries, Landfill Footprint, and buffer zones
- The final contours and remaining Site lifespan estimates
- The phased filling plan from 2016 to scheduled final closure in 2023
- The final cover design
- Operational procedures for waste acceptance and landfilling
- The conceptual modeling and design the surface water management plan
- The design and schedule for construction of upgrades to surface water management works
- The description of the leachate management plan and forecasted leachate quantities
- The LFG management facilities design plan and implementation schedule
- The contaminating life span estimates
- The environmental monitoring plan and implementation schedule for expansion of the monitoring well network
- Closure and post-closure requirements for the Landfill
- Contingency plan

1.7 Report Organization

This report is organized into the following sections:

- Section 1 – General introduction including Site location, background, the regional solid waste management context, the current regulatory setting applicable to the Site, report objectives and scope.
- Section 2 – Site physical setting including Site topography, hydrology, geology, hydrogeology, and climatic conditions.
- Section 3 – Outlines existing Site infrastructure, provides the design for Site infrastructure required to be constructed to achieve Landfill closure.

- Section 4 – Landfill capacity analysis, fill rates, apparent waste density, available airspace, landfill capacity estimate.
- Section 5 – Landfill development plan, Fill Plan, summary of works in each stage, materials management plan.
- Section 6 – Site operation including hours, Site security, authorized waste, traffic volumes, Site personnel, equipment requirements, cover requirements, nuisance controls, record keeping requirements, health and safety.
- Section 7 – Summary of geotechnical conditions, seismic evaluation, slope stability and cover stability analysis, and settlement.
- Section 8 – Surface water management plan including objectives and design criteria, surface water controls, hydrological analysis, surface water management infrastructure.
- Section 9 – Leachate management plan including objectives and design criteria, leachate quality and quantity forecasts, leachate management systems and leachate monitoring.
- Section 10 – LFG management plan including LFG production background, LFG regulatory criteria, previous LFG assessments and plans, and LFG monitoring and safety.
- Section 11 – Contaminating lifespan assessment.
- Section 12 – Closure plan, post closure site conditions, monitoring and maintenance requirements.
- Section 13 – Environmental Monitoring Plan (EMP) including surface water, groundwater, leachate, air and LFG monitoring, inspection and reporting requirements.
- Section 14 – Fire safety and emergency response plan.
- Section 15 – Contingency measures.

2. Site Physical Setting

The following section presents characteristics of the Site including, topography and drainage, geology, hydrogeology, and climate.

2.1 Topography

McIvor Lake is located approximately 400 m to the west of the Site with a lake elevation of approximately 180 m above mean sea level (AMSL), which is above the inferred original ground surface elevation beneath the Site (140 m AMSL).

Topography in the vicinity of the Site generally slopes downward to the east, from McIvor Lake, flattening out approximately 500 m to the east of the Site. The Site is located on the north side of a local valley. The narrow valley floor slopes to the east/northeast following the course of Argonaut Road. The valley appears to have been expanded laterally by historical soil extraction operations at the Site and to the southwest of the Site across Argonaut Road. Figure 2.1 presents the surrounding topography and nearby water bodies.

2.2 Drainage & Watercourses

2.2.1 Regional Surface Water Bodies

McIvor Lake, which is contiguous with Campbell Lake, is located approximately 400 m to the west of the Site. McIvor Lake is a dammed man-made lake which, drains to the north to John Hart Lake and ultimately discharges into the Campbell River. There are no surface water drainage courses from McIvor Lake to the Site or vice versa.

The Site is located within the Cold Creek watershed, which is a watershed within the Quinsam River watershed. Cold Creek includes several ephemeral tributaries as well as an unnamed pond that drains into one of the Cold Creek tributaries. The tributaries of Cold Creek generally flow to the northeast and discharge into the Quinsam River. The Quinsam River flows toward the north-northeast and discharges into the Campbell River approximately two kilometres downstream of the confluence of Cold Creek and the Quinsam River.

The closest natural surface water channel is located approximately 400 m northeast of the Site boundary and is one of tributaries of Cold Creek, which discharges into the Quinsam River. There are no surface water drainage courses from the Site to the Cold Creek tributaries. Figure 2.1 presents a watershed map of the area around the Site.

2.2.2 Site Drainage

There are no natural watercourses on the Site. A constructed surface water infiltration swale is located along the southeast of the Landfill Footprint which collects surface runoff from the southeast side of the Landfill. The surface water infiltration swale directs water into a culvert which runs along the toe of the MSE wall and outlets to a roadside ditch northeast of Block C. During periods of heavy rainfall, surface water has been observed to flow to northeast along the swale infiltrating into the ground surface within approximately 500 m of the Landfill Footprint.

A constructed surface water ditch is located along the northern perimeter of the Landfill Footprint, which collects surface runoff from the northern portion of the Landfill. The drainage ditch discharges into a series of surface water infiltration ponds in Block J, located adjacent to the northeastern corner of the landfill footprint.

The Site drainage works will be updated as described in the surface water management plan provided as part of this DOCP.

2.3 Geology

2.3.1 Regional Geology

Vancouver Island is part of the Wrangellia Terrane, which includes most of Vancouver Island, Haida Gwaii, and parts of central Alaska. The Wrangellia Terrane is composed mostly of widespread, late Triassic aged flood basalts (Greene, Scoates and Weis, 2005). Regional bedrock geology in the vicinity of the Site is composed of the Vancouver Group of mid to late Triassic age (Guthrie, 2003). The Vancouver Group is composed of undivided sedimentary rocks, marine sedimentary volcanic rocks, and small amounts of siltstones.

At several time periods during the Pleistocene Epoch, Vancouver Island was believed to be glaciated with ice thicknesses up to 2,000 m. During the recession of the last glaciation approximately 14,000 years ago, glacial and glacio-fluvial sediments were deposited, and in some cases reworked and redeposited, to make up many of the present surficial deposits of Vancouver Island. These deposits consist of till, which is deposited directly by glacial activity and consist of larger clasts supported in a matrix of fine grained sediment, and of glacial outwash, which consists primarily of poorly sorted, coarse grained (sand and gravel) sediments deposited by glacial melt water (Greene, Scoates and Weis, 2005). The overburden at the Site consists of glacio-fluvial and outwash deposits of sand and gravel.

2.3.2 Site Geology

The understanding of the Site geology presented in the following sections is based on existing Site borehole logs for the monitoring wells, provided in Appendix B, regional mapping, previous reports, and well completion logs from nearby private wells.

2.3.2.1 Overburden Geology

Overburden geology at the Site is relatively homogeneous and is primarily composed of deposits of fine to medium grained sand interbedded with deposits of fine to medium grained sand and medium subrounded gravel. Lenses of silt and fine grained sand up to four metres in thickness are present in an irregular distribution across the Site. Decommissioned monitoring well EBA04-5 was the deepest boring within the Site boundaries with a maximum depth of 67 metres below ground surface. Bedrock was not encountered at monitoring well EBA04-5. The location of the boring locations (monitoring wells) are illustrated on Figure 2.2.

2.3.2.2 Bedrock Geology

Based on Site borehole logs and private water supply well stratigraphy logs, bedrock has not been encountered in any boreholes advanced within the Site or immediately to the north and west of the Site, which are up to 67 metres deep. Bedrock is also not encountered at private water supply wells, which are approximately 60 metres deep and located approximately three km to the northeast to the Site. Bedrock is encountered at a depth of approximately 1.8 metres bgs approximately 1.5 km to the southwest of the Site based on well stratigraphy log for private water supply well adjacent to McIvor Lake. The bedrock lithology was not indicated on the well log.

2.4 Hydrogeology

The BC aquifer classification system lists Aquifer 975 to be present over the western portion of the Site. Aquifer 975 is classified as an unconfined sand and gravel aquifer of moderate productivity, high vulnerability, and low demand.

The groundwater elevations observed on-site in groundwater monitoring wells at and near the Site indicate groundwater flow is to the east northeast across the Site. Inferred groundwater contours calculated based on groundwater elevation data collected in November 2016 are presented in Figure 2.2.

Based on GHD field measurements, the water table in the vicinity of the Site is generally encountered at depths ranging from 20 to 30 m below ground surface (m BGS). Seasonal water table fluctuations of 0.6 m to 3.4 m were observed in 2016 with lowest groundwater elevations measured during the summer. Historical monitoring data shows that the depth to groundwater at monitoring well EBA04-4 is approximately 25 metres below the base of the waste.

2.5 Groundwater Use

From iMap BC (accessed July 25, 2017), eight water wells are located within a one km radius of the Site. Four of the eight water wells are listed for Commercial/Industrial use (well tags 39950, 74207, 84136, and 93413), three wells are listed as Private Domestic (well tags 73577, 103257, and 109728), and one well is listed as Unknown use (well tag 74191). The well licenses and a map indicating the well locations are included in Appendix C.

Well tag 84136 is included in the Site's environmental monitoring program (EMP) under the label EBA04-1. It should be noted the iMap indicates that well tag 84136 (labeled EBA04-1) is located at the southeast side of the Landfill Footprint, however, the identified location is likely inaccurate as the well's location has been visually confirmed by GHD to be located at the southwest corner of the Site.

Well tag 109728 was installed in January 2015 and appears to be located southeast of the landfill footprint on the south side of Argonaut Road. Well tags 39950, 73577, 74191, 74207, 93413, 103257 appear to be located hydraulically upgradient from the Site.

2.6 Surface Water Use

From iMap BC (accessed July 25, 2017), three surface water points of diversion are located within a one km radius of the Site. Each of these surface water licenses is listed for industrial use.

Surface water point of diversion CO61372 was issued to Canfarge Ltd in June 1967 for the diversion of surface water from a small water body called Antonelli Lake for gravel washing. It is unclear if surface water license CO61372 is still in use, as Antonelli Lake does not appear to exist (iMap, 2017). Surface water point of diversion CO59688 was issued to Tyco Paving Company Ltd in July 1983 to divert surface water from McIvor Lake for dust suppression. Surface water point of diversion 102940 was issued to Carl Kolonsky in June 1980 to divert surface water from McIvor Lake for fish culturing use.

Approximately 1.8 km east of the Site, the Department of Fisheries and Oceans (DFO) holds a surface water point of diversion license (CO39942) on Cold Creek to divert surface water for use at the Quinsam River Hatchery. The Quinsam River Hatchery is located on the Quinsam River approximately 3.5 km to the northeast of the Site. A copy of CO39942 is included in Appendix C.

2.7 Climate

The climate of the east coast of mid-Vancouver Island, where the Site is located, is marked by wet, mild winters, and warmer drier summers.

Data associated with climatic conditions for the Site were based upon Environment Canada's Climate Normals measured between 1981 and 2010 at the Quinsam River Hatchery (Climate ID: 1026639). Climate ID 1026639 is located approximately four km to the northeast of the Site at an elevation of approximately 45 m AMSL. The average annual precipitation is reported to be 1,618 millimetres (mm) with over 75 percent of the precipitation occurring between October and March. November and December experience the most precipitation with an average of 250 mm and 234 mm, respectively. On average 56 cm worth of snowfall is recorded per year. The average total monthly precipitation data and average daily temperature records are presented in Table 2.1.

3. Existing Landfill Infrastructure and Design

The following sections provide an overview of the existing and design features of the Landfill. The designs and plans presented in this DOCP represent a conceptual level design and will be developed to a final design level prior to construction.

3.1 Site Entrance and Material Recovery Area

The Site entrance is located on Argonaut Road. The entrance leads to a small parking lot to the west, the material recovery area to the east, and the weigh scales to the north. The material recovery area is a paved area accessible to the public for the drop-off of recyclable materials and household hazardous waste. The public does not need to pass over the scale to drop-off materials for recovery. The weigh scales are located just beyond the material recovery area adjacent to the scale house and Site offices. The transfer building is located just past the weigh scales and provides the public a tipping floor for waste drop-off. The waste is loaded onto haul trucks in the loading area on the south side of the transfer building and transported to the active face by the Landfill Contractor. The materials accepted at the material recovery facility and the waste drop-off facility are discussed in Section 6.10 and 6.12. The Site Entrance facility and material recovery are shown on Drawings C-01.

3.2 Existing Landfill Side Slopes and MSE Wall

As of October 20, 2016, the Landfill had been filled to an elevation of approximately 170 to 180 m AMSL, as shown on Drawings C-01. The side slopes have been filled to a slope of approximately 3H:1V. The side slopes have been mainly covered with intermediate cover, as described in Section 6.16.2.

On the eastern side of the Landfill, an MSE wall was constructed to buttress an existing steep landfill slope and provide additional airspace. The MSE wall consists of alternating layers of granular fill and geogrid or wire mat reinforcement. The external slope of the MSE wall consists of a vegetated wire facing units installed into the granular fill. The internal slope of the MSE wall is lined with a 60 mil LLDPE geomembrane with a 12 ounce non-woven geotextile installed for protection on both sides of the geomembrane. The geomembrane system acts as final cover for the lower portion of the slope adjacent to the MSW wall. The internal face of the MSE wall was backfilled against with a chimney drain consisting of crushed rock and granular fill.

A portion of the eastern side slope of the Landfill surrounding the MSE wall received final cover during the installation of the MSE wall. The limit of existing final cover is shown on Drawing C-02.

3.3 MSE Wall Toe Drain

The MSE wall toe drain is a 200 mm diameter perforated HDPE pipe installed at the base of the internal face of the MSE wall. The toe drain collects leachate from the waste placed behind the MSE wall and also surface water which percolates through the chimney drain inside the MSE wall during storm events. Leachate/surface water collected in MSE wall toe drain is directed to a sump located to the north of the MSE wall. The sump is a 1.2 m diameter HDPE pipe equipped with a liquid level sight gauge, and a hinged lid for removal of collected leachate.

3.4 Final Contours

The final contours were developed to maximize available airspace and meet the requirements of the Landfill Criteria. The final contour plan for the Site is comprised of an approximate pyramidal shape with 3H:1V side slopes that will extend upwards from the existing lower slopes presented on Drawings C-01. The pyramidal shape will converge to a small top plateau graded to 1:20 slopes at an elevation of approximately 194 m AMSL. The area of the Landfill that will receive final cover is 8.8 hectares. The final contours include a haul road cut into the slope running from the Site entrance area along the west and north side of the Landfill to the top plateau to provide access to the active faces. A maintenance road and side slope swale will be cut into the north and east side slope of the Landfill at elevations of approximately 168 to 172 m AMSL. The road dimensions are further discussed in Section 3.7. The side slope swales are further discussed in Section 8.

The final contours are presented on Drawing C-02.

3.5 Final Cover System

The final cover system was designed to minimize infiltration and corresponding leachate generation. The final cover design exceeds the requirements of the Landfill Criteria due to the inclusion of the geomembrane with a geocomposite drain. The final cover system will be placed over a minimum of 0.3 m of intermediate soil cover which will be placed upon reaching final waste contours in each phase. The final cover system will consist of the following layers (from bottom to top):

- Intermediate cover layer – to provide a smooth, consistent, cushion layer above the waste for the installation of the geomembrane barrier layer.
- 60 mil linear low-density polyethylene (LLDPE) geomembrane barrier layer – to prevent infiltration of precipitation and control the release of landfill gas.
- Geocomposite drainage layer – to provide protection against damage to the LLDPE geomembrane and to promote surface water runoff. The drainage layer will prevent the build-up of pore pressure on the geomembrane to reduce the likelihood of leakage through the geomembrane barrier layer.
- 0.6 metres of protective cover soil – to provide a ballast layer, separation from the waste and protection against damage to the geomembrane barrier layer.

- 0.15 metres of topsoil – to support vegetation that will provide protection against erosion, prevent damage to the underlying layers, and promote evapotranspiration of precipitation.

3.6 Surface Water Management

Surface water is managed via a series of on-site ditches and swales that direct surface water down and away from the Landfill. The ditch and swale network will be upgraded and expanded as the Landfill is developed. The surface water will be conveyed to a SWM Pond north of the Landfill, which will be constructed prior to the final closure of the Landfill. The surface water in the SWM Pond will infiltrate on-site, except during larger storm events when an overflow channel from the SWM Pond will convey overflow to the east and off-site along Argonaut Road.

The staged construction for the surface water management works are discussed in Section 5. The details of the surface water management criteria, hydrologic model and design are discussed in Section 8.

3.7 Access Roads

The Site access roads will be designed to provide safe all-weather access to the Landfill infrastructure during operation, closure, and post-closure periods. All permanent roads will have a maximum slope of 10 percent and be constructed with an adjacent surface water ditch to promote surface water runoff and drainage from the road.

The Landfill access roads will include the following road types:

- Existing perimeter access road
  - Approximately 3 metres wide
  - Provides access to the lower Landfill side slopes for maintenance
- Mid-slope access road
  - Designed to be 3 metres wide as shown on Detail 7 of Drawings C-14
  - Provides access to the final slopes of the Landfill for maintenance
- Temporary Haul Road
  - Approximately 10 metres wide
  - Provides access to the active face from the south
  - Will be used until the end of Stage 2 after which it will be decommissioned and waste will be placed overtop
- Haul Road
  - Designed to be 10 metres wide as shown on Detail 8 of Drawings C-14
  - Provides permanent access to the active face through to final closure
  - Will provide access to the top of the Landfill for maintenance during the post-closure operations

4. Landfill Capacity Analysis

The following section estimates the future airspace utilization rate to date by calculating the current apparent waste density. The apparent waste density is used to estimate the Landfill capacity at final contours and for each Stage of Landfill development, as discussed in Section 5.

4.1 Landfill Fill Rates

The existing fill rate has been approximately 25,000 tonnes per year. The same fill rates is expected to continue until 2019 while the CRWMC continues under the current operations and accepts the current waste streams.

The annual fill rate is forecasted to drop from 25,000 tonnes during Stage 2, or in 2019 as discussed in Section 5, to approximately 17,700 tonnes during Stage 3. This change in fill rate corresponds to the CWSM plan to divert walking floor trailers, currently accepted at the CRWMC, to the CVWMC.

4.2 Apparent Waste Density

The apparent waste density is a performance measure that represents the mass of waste measured across the scale discharged into each cubic metre of landfill air space. The volume of cover soils used each year is included in the annual airspace consumption but the mass of the cover soil is not included in the apparent waste density. Apparent waste density is a useful performance measure for assessing airspace utilization, Landfill life, and the efficiency of landfilling operations.

The apparent waste density is calculated by dividing the airspace consumed for a set period into the mass of waste landfilled. The airspace consumed is generally measured using aerial survey data of the Landfill at the beginning and end of the study period.

To calculate the apparent density at the Site, the study period of October 2015 to October 2016 was used. These dates correspond to the dates of the following aerial surveys:

- October 28, 2015 – survey completed by Highland Engineering and Surveying
- October 20, 2016 – survey completed by McElhanney Land Surveyors Ltd.

The mass of waste discharged into the Landfill during the same study period was obtained from the weigh scale data and provided by the CVRD.

Based on the tonnage of waste discharged and the airspace consumed from October 2015 to October 2016, the apparent waste density for 2016 was 0.61 tonne per cubic meter.

An apparent waste density of 0.6 tonne per cubic metre was used for the airspace capacity estimates discussed in the following Sections.

4.3 Remaining Airspace

The remaining airspace of the Landfill is estimated by comparing the existing conditions with the proposed final contours for the landfill, as discussed in Section 3.4. The existing conditions are

presented on Drawings C-01 and are based on survey data collected on October 20, 2016 by McElhanney Land Surveyors Ltd.

The final contours were designed by GHD and are presented on Drawings C-02.

The remaining airspace is the volume between the two surfaces that is available for filling. The remaining airspace for the Site is estimated to be 197,700 cubic metres. This represents the volume available for discharge of waste and placement of daily and intermediate cover throughout the remainder of the Site life.

4.4 Site Lifespan

The Site lifespan estimate is based on the following information:

- Apparent waste density of 0.6 tonnes of waste per cubic metre of airspace as estimated in Section 4.2.
- Approximately 197,700 m^3 of remaining airspace as estimated in Section 4.3.

The remaining capacity at the Site is approximately 118,620 tonnes. Based on the fill rates discussed in Section 4.1 the Site will reach capacity in approximately six years or mid-way through 2023.

5. Landfill Development Plan

The following section outlines the Landfill Development Plan through to final closure. The Landfill Development Plan consists of a seven-stage Fill Plan and Materials Management Plan.

5.1 Fill Plan

The Fill Plan was developed by GHD to allow an efficient plan to delineate landfilling areas over the remaining stages of the Site life in a manner that will progress towards the Site's final contours, discussed in Section 3.4. The Fill Plan consists of filling of the lower landfill side slopes until a level plateau is formed, then filling upwards on the plateau until to final contours are achieved. The Fill Plan was developed using the following criteria:

- Provide access to the active face for the haul trucks used at the Site:
  - From 2017 to 2019 the Site will receive waste via walking floor trailers, which require drive through roads to the active face.
  - From 2019 to 2023 (final closure) the Site will cease to accept walking floor trailers and access roads may be used in both directions with the use of a turnaround areas at the active face.
- Provide suitable capacity for each Stage based on the fill rate anticipated at the Site, as discussed in Section 4.1.

- Meet the requirements of the final contour design including filling waste on side slopes to maximum of 3H:1V (33 percent) and on the top plateau filling waste to a minimum of 1H:20V (5 percent).
- Allow waste to be placed via area fills and sliver fills. Area fills are rectangular fill areas on generally flat areas on the landfill plateau. The sliver fill method will be used on the landfill side slopes to fill the landfill side slopes to final top of waste contours.

The following sections describe each Stage of the Fill Plan in detail. Drawings C-01 and C-02 present the existing contours and proposed final contours of the landfill, respectively. Drawings C-03 to C-09 present the final conditions of each Stage of the Fill Plan. The airspace in each state and estimated completion dates of each Stage is presented in Table 5.1. Areas which have reached final waste contours will be promptly covered with intermediate cover until the Landfill has reached final contours and final closure is completed. Final closure may be completed over two construction seasons.

5.1.1 Stage 1

Stage 1 will involve area fills and sliver fills on west side slope. Waste will be placed from elevation 164 m to 177 m on the west slope. The permanent haul road and adjacent swale will be constructed up to an elevation of approximately 177 m. A culvert will be installed across the haul road at the base of the Landfill. The outer perimeter ditch west and north of the Landfill will be removed and the existing inner perimeter ditch will be reconstructed along the northern toe of the Landfill.

The capacity of Stage 1 is 34,400 m^3. The Stage 1 Site life is forecasted to be approximately nine months commencing at the beginning of 2017. Stage 1 is presented on Drawings C-03.

5.1.2 Stage 2

Stage 2 will involve area fills and sliver fills on southeast side slope and area fills on the northern and eastern side slopes. Waste will be placed from elevation 162 m to 175 m on the southeast slope, from elevation 165 m to 177 m on the eastern slope and from elevation 156 m to 177 m on the northern slope.

A temporary haul road and ditch will be constructed on the eastern and north side slope as shown in Drawing C-04. The temporary haul road is required to facilitate access of the walking floor trailers to the active face.

A mid-slope access road and swale will be constructed on the north, west, and south side slopes. A culvert will be installed across the east end of the mid-slope access road.

The capacity of Stage 2 is approximately 17,000 m^3. The Stage 2 Site life is forecasted to be six months beginning of the fourth quarter of 2017 to the Spring of 2018. Stage 2 is presented on Drawing C-04.

5.1.3 Stage 3

Stage 3 will involve filling the southern side slope, including the southwest corner from elevation 163 m to 177 m. The temporary haul road constructed in Stage 2 will be decommissioned to allow

the filling for Stage 3. All portions of the Landfill will have reached the elevation of 177 m by the end of Stage 3. Intermediate cover will be placed on the completed side slopes below 177 m.

The capacity of Stage 3 is approximately 16,850 m^3. The Stage 3 Site life is forecasted to be approximately six months from the Spring of 2018 to the Fall of 2018. Stage 3 is presented on Drawing C-05.

5.1.4 Stage 4

Stage 4 will involve filling the plateau from elevation 177 m to 181 m. The permanent haul road and adjacent ditch will be extended to the elevation of 181 m.

The capacity of Stage 4 is approximately 39,850 m^3. The Stage 4 Site life is forecasted to be approximately one year and a quarter. Stage 4 is forecasted to be completed the first quarter of 2020. Stage 4 is presented on Drawing C-05.

5.1.5 Stage 5

Stage 5 will involve filling the plateau from elevation 181 m to 184 m. The permanent haul road and adjacent ditch will be extended to the elevation of 184 m.

The capacity of Stage 5 is approximately 39,500 m^3. The Stage 5 Site life is forecasted to be approximately one year and a quarter. Stage 5 is forecasted to be complete halfway through 2021. Stage 5 is presented on Drawing C-07.

5.1.6 Stage 6

Stage 6 will involve filling the plateau from elevation 184 m to 187 m. The permanent haul road and adjacent ditch will be extended to the elevation of 187 m.

The capacity of Stage 6 is approximately 26,650 m^3. The Stage 6 Site life is forecasted to be approximately one year. Stage 6 is forecasted to be completed halfway through 2022. Stage 6 is presented on Drawing C-08.

5.1.7 Stage 7

Stage 7 will involve filling the plateau from elevation 187 m to 194 m, which represents final contours. The permanent haul road and adjacent ditch will be extended to the elevation of 194 m.

The capacity of Stage 7 is approximately 23,450 m^3. The Stage 7 Site life is forecasted to be approximately nine months. The final contours are forecasted to be reach during the first quarter of 2023. Stage 7 is presented in Drawing C-09. The Final Contours are presented in Drawings C-02.

The application of final cover may begin in 2022 on the lower slopes and be completed in 2023, once the final contours have been achieved.

5.2 Material Requirements

Based on the planned site operations and closure, a total of approximately 93,000 m^3 of granular fill will be required for daily, intermediate and final cover. Construction of the final cover will also

require the placement of an estimated 14,000 m^3 of topsoil. Details of the material requirements by Stage are presented in Table 5.2.

Fill materials for daily and intermediate cover and the protective cover layer of the final cover (i.e. excluding topsoil) will be sourced from the excavation required to construct the SWM Pond as discussed in Section 8.4.3. The construction of the SWM Pond will produce an estimated 65,000 m^3 of granular fill suitable for use as cover soil. Additional granular material will be excavated from the borrow area located at the northeast of the Site and north of the SWM Pond. Should sufficient material not be available from on Site excavations, granular fill may be imported from off-site sources. All topsoil for final cover will be imported from off-site sources.

6. Site Operations

The following section presents an overview of landfill operations and operational procedures for the Site.

6.1 Site Management

Berry and Vale Contracting Ltd. operates the CRWMC under contract with CVRD. The Site is leased and managed by CVRD.

6.2 Site Fencing and Signage

The Site is equipped with a chain link fence and lockable gate, which extends along the majority of the south and southeast boundaries of the Site along Argonaut Road. The Site is also equipped with an electric bear fence which extends around the perimeter of the Landfill. The household hazardous waste storage area is also contained within a barbed wire topped chain-link fence with a lockable gate.

A site operation sign is present at the front of the Site with the Site name, hours of operation, and contact information for the Landfill Owner. Further signage is placed in all public drop-off areas indicating acceptable wastes for each storage and drop-off area. Additional signage is present indicating potential hazards to staff and the public, including potential hazardous materials (e.g. household hazardous wastes (HHW), batteries, electrical hazards and fall hazards).

Signage is to be maintained in legible condition and to be updated as required to reflect changes in waste acceptance policies, contact information and operational hours.

6.3 Weigh Scale

Two weigh scales are currently located at the Site entrance (one for entry, another for exit weighing). Scales will continue to be used for the Landfill operations.

Weigh scales are to be maintained in proper working order including meeting the requirements of the federal Weights and Measures Act via periodic inspection and calibration by a third party contractor.

6.4 Operational Personnel

Site operational staff are employed by Barry and Vale Contracting Ltd. and will include the following personnel:

- Site Supervisor: Responsible for overall oversight and organization of Site operations, maintenance of Site records, health and safety, and training of employees.
- Scale Operator: Weighs and assesses incoming wastes. Determines acceptability of incoming wastes and appropriate refuse type and disposal location.
- Truck Driver: Transfers waste bins from public drop-off area to appropriate area of the Landfill as required.
- Equipment Operator: Places and compacts waste at active face after drop-off from commercial vehicles and public drop-off bins.
- Three Transfer Station Attendants: Attend public waste drop off area, direct incoming traffic and refuse drop-off to appropriate disposal bay in coordination with the scale operator. Maintain clean and safe work environment in the public drop-off areas.

6.5 Operational Training

The Site Supervisor must be trained in landfill operations by completing the SWANA BC Landfill Operations Basics (LOB) course or equivalent, and landfill operations management by completing the SWANA Manager of Landfill Operations (MOLO) course or equivalent. Staff trained in first aid should also be present at all times during landfill operations. Staff must also be trained in the hazards of asbestos containing waste, proper handling procedures, and risk mitigation measures for its handling.

6.6 Site Health and Safety Plan

A Site Health and Safety Plan (HASP) will be prepared and kept on Site at all times. The Site operations will meet the requirements of WorkSafeBC.

6.7 Hours of Operation

The Site will be open for public drop-off seven days a week and all statutory holidays except for Christmas Day and New Years' Day from 8:30 a.m. to 5:30 p.m. The HHW storage area will be open Tuesdays, Wednesdays, and one Saturday per month from 9:30 a.m. to 5:30 p.m.

6.8 Traffic Volumes

Traffic volumes will vary based on public drop-off rates which vary significantly primarily based on season and weather. Based on 2016 scale data, the Site receives on average approximately 120 vehicle loads per day.

6.9 Neighbour Relations Plan

CVRD recognizes the need to maintain positive relations with landowners adjacent to and nearby the Site. Ongoing efforts to mitigate the impacts of nuisance factors such as dust, litter, odour and vectors will be carried out in accordance with the protocols discussed in the following sections.

All operational complaints received by Landfill personnel will be recorded and directed to the Site Supervisor and/or CSWM staff as required. The Landfill personnel will undertake corrective action(s) as soon as possible after identification of need. A complaint response procedure, including an email address and phone number, will be provided at the Site entrance for the submission of nuisance complaints from the public. The complaint, nature of complaint, time received and corrective action taken will be documented and included in the Site records. The records must be kept in accordance with the record keeping procedures described in Section 6.23. Complaints received and actions to resolve complaints are to be included in the next annual operations report, as appropriate.

6.10 Authorized Wastes

The OC permits the disposal of waste at the Landfill characterized as MSW as defined under the EMA, and other wastes as approved in writing by the Regional Waste Manager. Specifically, the CSWM accepts the following wastes for disposal at the CRWMC:

- Regular household wastes
- Residential roofing materials
- All clean wood waste (unpainted lumber, pallets, wood shingles)
- Yard waste (branches, leaves, grass clippings, and kitchen waste)
- Construction and demolition waste
- Contaminated wood waste (painted, pressure treated, OSB and plywood)
- Animal carcasses and offal
- Clean fill
- Asbestos containing materials (ACM)

The waste not accepted for disposal at the Site:

- All paints
- Biochemical waste
- Fuels and solvents
- Contaminated soils above CSR industrial standards
- Materials that are on fire

6.11 Waste Acceptance Policy

6.11.1 Soil

Prior to the acceptance of soil at the Site, CRWMC will require the completion of the Waste Profile Sheet (WPS) and representative soil quality data, in accordance with Contaminated Site Regulation (CSR) and Hazardous Waste Regulation (HWR). Waste Profile Sheets require the signature of a Qualified Professional (QP) confirming the samples collected and analyzed are representative of the soil in question. The submitted data will be compared by CRWMC to the Site acceptance criteria to ensure compliance with the OC.

6.11.2 Construction and Demolition Waste

Prior to the acceptance of construction and demolition (C&D) waste, the C&D waste will be subject to a waste screening process. Material from deconstructed houses or renovations must be accompanied with record Hazard Assessment, as per WorkSafeBC's requirement to confirm the presence of asbestos or other hazardous materials. Additional testing to confirm the C&D waste is non-hazardous may be required as per the requirements of the HWR and MOE Technical Guidance. The submitted data will be compared to the Site acceptance criteria to ensure compliance with the OC. Construction debris from new construction will not require a hazard assessment.

6.11.3 Controlled Waste

The CRVD accepts animal carcasses, which are defined by the Landfill Criteria as controlled waste. Animal carcasses declared at the weigh scale are immediately directed to the Landfill Contractor to ensure timely and appropriate disposal. Animal carcasses are disposed of in an excavated trench near the active face and promptly buried with a minimum of 1 m granular fill.

6.11.4 Asbestos Containing Material

The following guidelines must be followed for the handing of asbestos containing material (ACM):

- Waste asbestos as defined in the BC HWR must be transported in compliance with the Transportation of Dangerous Goods Act and Regulations and disposed of in accordance with Part 6, Section 40 of the HWR.
- Waste asbestos must be deposited in dedicated asbestos trenches excavated into the waste at the active face where no further excavation is scheduled to occur and must be immediately buried with at least 0.5 m of cover material.
- Asbestos trenches must be surveyed as they are filled. Records of the location of the asbestos trenches are to be maintained on Site and no excavation is to occur in the vicinity of the trenches.

6.12 Material Recovery

Materials accepted for storage and recovery are collected in the Site transfer station in dedicated containers (bins, supersacks, drums, oil storage bins) for collection and off-Site processing. Materials recovered from the incoming waste streams for recovery include:

- Cardboard and mixed paper
- Plastic containers (Types 1-7)
- Tires
- Propane Tanks
- Household and automotive batteries
- Appliances
- Scrap Metal
- Used Oil
- Electrical Items
- Light bulbs
- All materials included under the RecycleBC program
- All materials included under the ReGeneration Program by ProductCare

HHW are collected for storage and periodic off-Site processing/disposal by third party contractors. HHW accepted include oxidizers (bleach, pool chemicals), corrosive bases (heavy duty cleaners, ammonia, oven and glass cleaners, disinfectants), toxics (pesticides, fertilizers, poisons, cleaners, herbicides, and wood preservatives), adhesives (resins, roof patch, tars, glues, and sealants), paint products, paint aerosols, pesticides, flammable liquids, gasoline, other solvents and fuels.

6.13 Equipment Requirements

Under current operations, the following equipment is required for the activities indicated:

- Construction, maintenance and removal of access roadways and cover (daily and intermediate):
  - Dozer
  - Excavator
  - Gravel Truck
- Waste Placement:
  - Walking floor trailers and associated semi-truck
  - Waste compactor (minimum 45,000 kg)
  - Dozer

- Site maintenance (clearing and cleanup):
  - Bobcat

The use of walking floor trailers on the Landfill is expected to cease in approximately 2019. Upon the cessation of their use on the Landfill, walking floor trailers will continue to operate at the Site to transfer waste to CVWMC.

The following list presents the equipment currently available on Site and is subject to change based on changes to Site operation and equipment maintenance:

- 370A Trashmaster Compactor
- John Deere Dozer (spare)
- 370 Trashmaster Compactor (spare)
- Volvo Front end loader
- Sterling Rail Truck (roll-off truck)
- Kenworth Rail Truck (spare)
- EX 200 Hitachi Excavator (Part Time)
- Sterling Gravel Truck (Part Time)
- 2 Walking floor trailers
- 2 Mac Highway trucks (one in operation, one spare)
- Sanding truck
- Bobcat (sweeper and lifting forks)
- JCB rubber tire backhoe
- Case rubber tire backhoe (spare)

6.14 Access Roadways

Site access roads will be constructed to provide access to on-Site facilities and for conducting inspection and maintenance of Landfill infrastructure. The access roads must be inspected and maintained, as necessary, to ensure the adequate conditions for operational vehicles and emergency egress.

6.15 Landfilling of Wastes

The following general waste placement practices will be implemented at the Site to optimize Site development, waste capacity, minimize water infiltration into the landfill, and reduce litter, vectors, odours and maximize the efficiency of operational cover use:

- Maintain a minimum active face area sufficient for the safe unloading of waste and traffic operations. The Landfill Criteria recommends a maximum active face area of 243 m^2 for a landfill receiving 20,000 to 50,000 tonnes of waste per year.

- Minimize the lift height to optimize compaction. The Landfill Criteria recommend maximum lift height of 2.5 metres for a landfill receiving 20,000 to 50,000 tonnes of waste per year.
- Complete a minimum of 3 passes per lift with a compactor of minimum weight of 45,000 kg.
- Landfill waste in accordance with the Fill Plan to achieve final contours on side slopes as early as possible for the placement of intermediate cover.
- Divert surface water runoff away from the active landfilling area to minimize infiltration and subsequent leachate generation.

6.16 Cover Placement

Cover is to be applied as required by the Landfill Criteria in order to deter vectors, wildlife and scavenging and to reduce the likelihood of fires, windblown litter, odour, water infiltration, and LFG release.

6.16.1 Daily Cover

Daily cover will be placed on the active face at the end of each operating day. Daily cover will consist of either 0.15 m of industrial quality soil or approved alternative daily cover (ADC). Soil used for daily cover may be removed from the active face immediately prior to landfilling in the same area.

ADC may be used to improve the airspace utilization rates. ADC used at the Site may include:

- Tarps
- Steel plates
- A non-reusable geosynthetic material

Daily cover may be removed prior to landfilling of additional waste.

Daily cover is currently sourced from a borrow pit located on Block J at the northeast of the Site, and consists of native granular soil. Unless, or until, ADC is employed at the Site, the borrow pit will continue to be used as the primary source of daily cover until the Landfill closes.

6.16.2 Intermediate Cover

Intermediate Cover will be placed on areas of the Landfill that are not scheduled to receive additional waste for 30 days or more. Intermediate cover will consist of 0.3 m of granular material. The thickness may include daily cover if daily cover is present in the area. Soil used for intermediate cover may be removed from the active face immediately prior to landfilling in the same area.

Intermediate cover is currently sourced from a borrow pit located on Block J at the northeast of the Site and consists of native granular soil.

6.16.3 Final Cover

Final Cover will be placed once the Landfill has been constructed to final contours. The final cover system will be applied over 0.3 m intermediate cover and will consist of the following layers from top to bottom:

- 0.15 m of topsoil with suitable vegetation
- 0.6 m of protective cover soil (on-Site sand)
- Geocomposite drainage layer
- 60 mil LLDPE membrane

The final cover system layers are presented on Drawing C-12. A water balance model, as discussed in Section 9.2, was used to estimate the resulting infiltration through the final cover system. The results forecast this final cover system to exceed the performance of the minimum final cover specified in the Landfill Criteria (0.6 m of low permeable soil).

The protective cover soil layer will be sourced from the onsite borrow pit located at the north east of the Site on Block J.

6.17 Surface Water Management Works Operations

6.17.1 Management of Surface Water on Active Face

Operators will consider surface water that comes into contact with the active face, daily cover and/or mixes with water that has come into contact with the active face and/or daily cover as leachate. Operators will prevent all water considered leachate from entering the surface water management system by the installation of berms, swales and grading of the active face and surrounding areas.

Works designed to isolate surface water which has come into contact with the active face should be regularly inspected, repaired and moved/upgraded as necessary based on changes to the active face to ensure they remain effective.

6.17.2 Surface Water Management Pond

The SWM Pond will require regular maintenance to ensure adequate level of sediment removal and design infiltration rates are achieved. Outfalls and inlet structures should be inspected regularly, and repaired as necessary. Vegetation on banks should be cut at a minimum twice per year to maintain design capacity and safe access. The forebays and ponds should be inspected annually to estimate the level of sediment accumulation, and sediment should be excavated from the base every five years or more frequently as needed to maintain design capacity.

6.17.3 Drainage Ditches

Ditches constructed on areas of the Landfill, which have received final cover, will require maintenance of vegetation to ensure that their design capacities are maintained and erosion, if any,

is corrected. Typically, vegetation in ditching is cut one to four times per year; however, a maintenance schedule should be developed based on the actual growth rate.

Drainage channels will also be inspected for damage caused by settlement, sloughing, erosion. Ditches channels, liners, culvert inlets and outlets and culverts will be inspected to ensure that design flows and capacities are maintained. Damage will be noted and repaired as soon as practical.

6.18 Leachate Toe Drain Maintenance

The leachate toe drain on the east side of the Landfill drains to a sump located near the northeast corner of the Landfill Footprint. The water level in the sump is measured and recorded weekly by Site staff. Leachate/surface water is removed by pump truck as required. Pumped leachate/surface water is currently recirculated through the Landfill. Leachate/surface water removed from the sump will be transferred to the CVWMC leachate treatment facility for treatment upon its commissioning, scheduled for 2018.

6.19 Landfill Gas Monitoring

There is currently no LFG infrastructure at the Landfill. Section 10 presents the LFG Management Plan including monitoring requirements as required by the LFG Management Regulation (B.C. Reg. 391/2008).

6.20 Nuisance Controls

The Landfill will comply with all local government nuisance bylaws. The following section presents practices undertaken at the Landfill to minimize nuisance impacts from Site operations.

6.20.1 Dust Control

Dust generation is common at most landfill sites due to the handling of soils, dry waste (such as demolition waste, plaster, and concrete), as well as the movement of vehicles along gravel and dirt access roads. Dust mitigation measure will be employed at the Site on an as-needed basis and may include the following measures:

- Reduction of allowable vehicular speeds
- Use of water to control dust
- Seeding programs
- Proper placement of stockpiles and covers to minimize dispersion
- Seeding of soil stockpiles that will not be used for more than three months

6.20.2 Noise Control

Potential noise impacts from the Site may result from the operation of the landfill equipment and bird control devices. The operation of Site equipment will comply with the noise emission standards as outlined in the Society of Automotive Engineers (S.A.E.) J88 – Latest Edition "Sound

Measurement – Earth moving Machinery". Noise mitigation will also be provided by the following Site features:

- Vegetative buffer zones
- Distance of Landfill operations from Site boundary and neighboring properties
- Noise based active bird control measures should be limited to 8:00 a.m. to 5:00 p.m. and should be minimized by supplementing with alternative bird control measures (e.g. trained birds of prey)

6.20.3 Litter Control

Preventative litter control measures are steps taken to minimize the blowing of litter from the active area of the Landfill and from incoming waste loads. Litter should be prevented from migrating beyond the Site property boundary. The following measures will be used at the Site to control and minimize windblown litter:

- All loads must be tarped to prevent litter from blowing out of the vehicle. CRWMC reserves the right to not accept loads that are not tarped.
- The active face will be selected based on the direction and intensity of the wind to provide maximum shelter for the active area. The aerial extent of the working face will be kept to a minimum on windy days.
- Litter will be collected within the Site and along the Site boundaries when necessary.
- Cover soils will be applied as outlined in Section 6.16.
- Litter fences and operational berms will be installed as necessary within the Landfill.

6.20.4 Odour Control

Landfill operations are carried out in a manner that minimizes the generation of nuisance odours from the deposition or exposure of putrescible wastes. The following measures will be used at the Site to control and minimize nuisance odours:

- Cover soils will be applied as outlined in Section 6.16.
- When highly odorous waste is anticipated, a dedicated area may be developed within the Landfill and cover will be applied directly after waste placement.

6.20.5 Sight Lines

Measures shall be undertaken to reasonably minimize sight lines to the active face of the Landfill from the Gold River Highway and Argonaut Road. To minimize the sight lines the following measures will be implemented:

- Intermediate and daily cover will be applied to the active face as outlined in Section 6.16.
- Berms will be installed within the Landfill active area to minimize sightlines to exposed waste, when necessary.

6.21 Vectors, Wildlife Management

Vector control is accomplished by Site fencing, the application of daily, intermediate and final cover, and the use of active vector controls. To minimize the vector and wildlife impacts on Site the following measures are to be implemented:

- Daily, intermediate and final cover will be applied to the active face as outlined in Section 6.16.
- Litter will be minimized through good housekeeping practices and litter control as described in Section 6.19.3.
- The electric fence will be maintained to deter the entry of bears and other large mammals.
- Active bird control measures may be utilized. Active bird control methods will include the use of trained birds of prey, and starter pistols with screamers and bangers.
- The effectiveness of bird control measures will be monitored and adjusted based on their effectiveness and on seasonal variations in bird populations at the Site.
- Rodent control measures including rodent traps maintained by a third party contractor.

6.22 Scavenging

Scavenging is defined in the Landfill Criteria as the informal and unauthorized recovery and removal of waste. Scavenging of waste from the active face and within the Site is prohibited due to health and safety concerns. Illegal scavenging is prevented by limiting access to the landfill and to the drop-off bins to CRWMC staff.

6.23 Winter and Wet Weather Operation

Winter operations require advanced planning for Site preparation, snow removal, and the stockpiling and storage of cover material.

An area sufficient to hold more than the expected volume of waste should be prepared in advance of the onset of winter. In addition, stockpiles of cover material and areas for stockpiling snow should be provided and placed prior to the onset of winter.

During the winter months the active disposal area will be located in such a manner so as to be free draining with flatter grades in working areas to facilitate equipment travel. Up to twice the estimated required area for disposal through the winter months will be prepared to minimize problems due to snow and equipment failure.

Runoff from snowmelt will be treated as storm water and will not flow into the active disposal area. Water which has contacted waste will be managed as leachate.

During wet weather operations, surface water will be directed away from the active disposal area by means of temporary soil berms constructed upslope of the active area, as required. Under extremely wet weather conditions, the waste disposal operations may be moved to drier working areas to facilitate vehicle travel at the working face.

On-site equipment used for continued Site operations during rainfall events, will be provided with closed cabs.

Site roadways will be maintained in a passable condition during wet weather conditions. Secondary haul roads to the active face will be located so as to ensure continuous access to the active face during wet weather conditions. Should washouts of the Site roadways occur due to rainfall events, the roadways will be reconstructed in a timely fashion.

6.24 Records

All relevant records will be maintained by the Site owner for the remaining operating life of the Landfill and the duration post-closure operations and monitoring period. Relevant records will be maintained on-Site for a minimum of seven years. The records must be available on Site for inspection and must be submitted to the Director (as defined in the EMA) within 14 days of a request from the MOE. Records to be maintained on Site include the following:

- The OC
- All plans and reports prepared in support of the development for the Site
- Inspection records conducted by regulatory agencies
- A complaint log system providing source of complaint, nature of complaint, time received and actions taken
- Waste tonnages and volumes disposed of in the Landfill for each category of waste received
- Waste sources, characterization and approvals
- Maintenance records including date and time of inspection, inspector name and signature, weather and environmental conditions, checklist of specific items to be inspected, narrative of observations and conditions, a list of any specific items noted for further action (repair, maintenance etc.), and cross reference to show the actions that were implemented to correct the problem.

7. Geotechnical and Seismic Assessment

This section presents the results of the analysis of the slope stability and cover stability of the proposed final conditions of the Landfill for static and seismic conditions.

7.1 Geotechnical Overview

As discussed in Section 2, the Site consists of deep layers of sand and gravel, silt and sand, and gravelly sand deposits of at least 40 m, which extend past borehole termination of all local boreholes. The overburden is generally in compact to dense conditions, with SPT 'N' values generally in the ranges of 20 to 50 blows per 0.3 m of penetration.

Given the age of the Landfill and the sparsity of the existing boreholes, it is difficult to estimate the elevation of the native granular soils below the landfilled waste across the entire Landfill Footprint. Based on borehole information near the MSE wall on the east side of the Site, native soils are first

encountered at an elevation of 136.0 m to 140.3 m AMSL and extend below an elevation of 100 m AMSL. Limited borehole information exists below the remainder of the Landfill. For this reason, a conservative top of native soil elevation of 132 m AMSL has been assumed below the majority of the Landfill. This is consistent with the elevation assumed in the memorandum titled "Report on Seismic Risk Assessment Related to Liquefaction Potential", dated October 12, 2012 (exp, 2012).

7.2 Seismic Evaluation

The level of seismic hazards defined for the Campbell River area as obtained from Natural Resources of Canada (NRC) website are presented in Appendix D. The level of hazards as per National Building Code of Canada 2015 (NBCC 2015) is slightly higher than the ones in NBCC 2010 (NBCC 2010); however the difference is not considered significant. The British Columbia Building Code (BCBC 2012), which is the applicable regulation, adopted the same seismic provisions as NBCC 2010. Therefore, in this discussion, reference is made to NBCC 2010. The calculated seismic hazards for the Site, as per NBCC 2010 (provided by NRCC) for different probabilities, are provided in Appendix D. These values are provided for firm ground (site Class C).

The NBCC specifies that buildings and their components should be designed for seismic events with 2 percent probability of exceedance in 50 years (i.e., return period of 2475 years). However, the Code does not specifically comment on the appropriate seismic event for landfills or earth structures. The US Environmental Protection Agency Resource Conservation and Recovery Act (RCRA) Subtitle D (Richardson et. al., 1995) states that hazardous waste landfill facilities and its engineered components should be designed for maximum horizontal acceleration resulting from a seismic event with a 10 percent probability of exceedance in 250 years (i.e., return period of 2373 years).

Considering the nature of the Landfill and the low consequences of its failure during an extreme seismic event, NBCC 2010 and RCRA Subtitle D provide very conservative design criteria, especially for short-term conditions. Therefore, in the absence of a specific design code for this application for the seismic condition present at this Site. A design based on a seismic event with 10 percent probability of exceedance in 50 years (return period of 475 years) is appropriate for this Site. However, to account for the unknown properties of the newly placed waste material and potential seismic amplifications due to its unconsolidated nature, a seismic event with 5 percent probability of exceedance in 50 years (return period of 1000 years) is considered for stability evaluations in the short term. For the post construction conditions, the design should be based on a seismic event with 2 percent probability of exceedance in 50 years (return period of 2475 years).

7.2.1 Liquefaction Potential

Soils most susceptible to liquefaction are loose, fine granular soils below the water table. Groundwater was not encountered in any boreholes, used in the evaluation, to a maximum depth of 25.6 m below ground surface (below elevation 115.4 m AMSL). In addition, exp (2012) conducted a sensitivity analysis considering the unlikely scenario of a major earthquake inducing the groundwater table to rise to a depth of 15 m below ground surface. Through calculations of the Cyclic Resistance Ratio (CRR) derived from the measured standard penetration test (SPT) data, it was determined that liquefaction potential was low and therefore foundation failure or impact on foundation stability due to liquefaction was not considered an issue.

7.3 Slope Stability

The following section discusses the analyses carried out to determine the long-term global stability of the proposed 3H:1V side slopes of the landfill.

7.3.1 Slope Stability Cross Section

A cross-section (A-A') for the west slope of the Landfill has been analyzed as a worst-case scenario. This cross-section was selected due to the as approximately 10-13 m high MSE wall (varying along its length) located at the northeast side of Block C. The location of the cross-section is presented in Figure 7.1.

7.3.2 Global Stability

The slope stability analyses were performed using limit equilibrium method through Slope/W, a module of the commercially available software Geo-Studio 2012 developed and distributed by Geo-Slope International, Calgary, Alberta.

The properties required for the stability analyses of the slopes are the bulk densities and shear strength parameters of the materials involved. These material properties have been selected based on a literature review; the properties used in the analyses are shown on the graphical outputs of the static and pseudo-static (seismic) slope stability analyses included as Figure 7.2 and Figure 7.3, respectively.

7.3.3 Pseudo-Seismic Analysis

The effect of seismic (earthquake) forces on slope stability was determined through pseudo-static analysis. A pseudo-static analysis is an extension of static methods wherein the inertia forces due to earthquake shaking are incorporated into the static methods by a constant horizontal force, equal to the weight of the potential sliding mass multiplied by a coefficient. The coefficient is typically the peak horizontal acceleration 'a_{max}' or a fraction thereof.

The peak horizontal ground acceleration 'a_{max}' for Campbell River area of 0.281g was derived from the zoning map developed by the Geological Survey of Canada (GSC); where 'g' is the gravitational force. The a_{max} value from the GSC map considered in the calculations corresponds to a probability of exceedance of 2 percent in 50 years (recommended design criteria). The seismicity of the Campbell River area obtained from the GSC website is presented in Appendix D. A value equal to half of the a_{max} value was used in the slope stability analyses. A review of the technical literature such as Hynes-Griffin (1984) shows that the use of 50 percent of the a_{max} is recommended as the peak seismic acceleration occurs only for a fraction of a second. Use of the peak value is therefore considered very conservative. Use of 50 percent of a_{max} is recommended with shear strength values reduced to 80 percent of the peak values. The shear strength values used for the static analyses are already considered conservative, therefore use of 50 percent of a_{max} is considered realistic.

7.3.4 Targeted Factor of Safety

The stability analysis results were calculated in terms of minimum factors of safety for static and pseudo-static analyses. A factor of safety (FS) in slope stability analysis can be defined as the ratio

of the available shear strength to that of the applied shear stresses along a potential failure plane. A factor of safety of 1 or greater indicates stable conditions, and a value of less than 1 represents unstable conditions. Typically, a target factor of safety greater than 1, typically 1.5 or higher, is considered reasonable for long-term static slope stability analyses in order to account for the uncertainties in the assumed shear strength parameters and subsurface soil and groundwater conditions. Due to the transient nature of seismic forces, a factor of safety of 1.1 is considered acceptable for pseudo-static analyses. Accordingly factors of safety of 1.5 and 1.1 were targeted for the static and pseudo-static analyses, respectively.

7.3.5 Slope Stability Analysis Results

The slope stability analyses for slope A-A' resulted in a FS of 2.49 for static conditions and a FS of 1.65 for the pseudo-static conditions. The calculated FSs indicate the slopes are acceptable for design.

7.4 Veneer Cover Stability

The proposed Landfill cover on the 3H:1V Landfill side slopes is outlined in Drawing C-12. The proposed cover system due to the relatively steep slopes of 3H:1V is not anticipated to be partly or full saturated; therefore analyses were carried out assuming a nominal water head of 0 mm above the textured LLDPE liner as a geocomposite drain has been specified above the LLDPE. This analysis should be reevaluated during the final cap design with properties from actual materials that will be used in the final design.

The interface shear strength is a function of the shear strength of the two materials forming an interface in a cover system comprised of multiple components. The sliding stability analyses are carried out to evaluate the potential of sliding along a geosynthetic layer interface as this type of sliding may tear the geosynthetic material. Shear testing should be performed to evaluate the sliding potential of the actual materials used in design. The interface shear strength is further governed by the weaker material at the interface. The shear strength parameters used are shown on the analyses provided on Table 7.1.

The analyses were carried out using the infinite Slope method proposed in Richardson et. al. (1995), and the results are provided in Table 7.1. A review of the results shows the targeted factors of safety for static conditions were achieved (factor of safety of 1.51) for the proposed cover system placed on 3H:1V, with a marginally low factor of safety of 1.01 for the pseudo-static conditions. Hence the proposed cover system is expected to be stable under the conditions noted above.

Yield accelerations, exceedance of which will trigger cover movements, were calculated as fractions of gravitational forces during the pseudo-static analyses. The values of calculated yield accelerations are provided for each cover system interface on Table 7.1. According to Griffin & Hynes (1984), slopes and embankments with yield acceleration equal to 50 percent of peak ground acceleration (PGA) will experience permanent seismic deformation of less than 1 m in any earthquake even where seismic acceleration is amplified by a factor of three. A review of the results show that the yield strength of the cover system marginally exceed 50 percent of the PGA meaning that permanent deformation is unlikely to exceed 1 m in any earthquake event where seismic acceleration is amplified by a factor of three.

Prior to construction of the final landfill cap, it is recommended that interface shear tests be performed with the actual materials of construction to confirm the preliminary veneer slope stability evaluation provided above. A reevaluation of the slope stability should be performed with actual final cover material properties. In addition, to ensure no water head buildup on the geocomposite drain, proper selection and modeling of the geocomposite drain will be required for the final Landfill cover design. Drainage of water from the geocomposite drain at the Landfill perimeter is another critical component of the final cap design, to ensure that the infiltrated water conveyed by the geocomposite drain can be adequately discharged to surface. This level of final design has not been included in this report.

7.5 Settlement

Settlement analysis of the landfilled materials has not been completed at this time as this analysis will primarily be used for the final cover design. Prior to detailed design of the final cover system, settlement analysis should be completed to estimate for short-term settlement, long-term settlement, and creep. The results will be considered during detailed design to ensure the design provides allowance for forecasted settlement.

Very little information exists for interpretation of settlement parameters of the waste material in the landfill based on the previous investigations that have been completed. Settlement parameters will need to be developed in order to perform settlement analysis required for the final cover design. To develop these parameters, it is recommended that settlement monitoring plates be installed and surveying of the Landfill be completed periodically over the upcoming years to determine the magnitude and rate of settlement.

8. Surface Water Management Plan

8.1 Surface Water Management Criteria

The surface water management works will be designed and constructed to meet the following Landfill Criteria requirements:

- Prevent surface water run-on onto the Landfill footprint during operations
- Ensure that surface water runoff/discharge from the Site will not adversely impact receiving water downstream of the Site
- Minimize the potential for erosion of cover soils
- Control surface water flow from the clean soil covers from the Landfill
- Design storm water ditching for the conveyance of the design storm event of 1:100-year, 24-hour storm event
- Design SWM Pond for the storage and infiltration of the 1:25-year, 24-hour storm event, and outflow discharge matching pre-development peak discharge rate during the 1:100-year, 24-hour storm event

- Stabilize ditching with armoring systems on slopes greater than 2 percent (turf reinforcement matting on slopes of two to ten percent and concrete link matts on slopes greater than 10 percent)

8.2 Surface Water Management Strategy

The surface water management criteria listed in Section 8.1 will be achieved with the construction of a series of mid-slope swales, ditches and the SWM Pond to manage the surface water. In general, the surface water generated on the west, north, and upper portion of the Landfill will be conveyed to the west and north toward the SWM Pond. The surface water generated on the lower portion of the east Landfill slopes will be collected in the eastern perimeter ditch and conveyed to the north along Argonaut Road. The east and west perimeter ditches join together and discharge to the SWM Pond in Block J. The location of the surface water ditches are shown on Drawing C-03.

The SWM Pond will include a lined forebay with a permanent pool for energy dissipation during storm events followed by an unlined main pond area. The strategy is to allow for surface water to infiltrate in the SWM Pond under smaller storm events. During the 1-100-year, 24-hour storm event some water will overflow into the outlet pipe and channel discharging to the east off-site. The pond will allow for settling of sediments prior to surface water discharge. The following sections discuss the surface water analysis and expected flows.

8.3 Hydrologic Assessment

A hydrologic assessment of the Site watershed was completed to provide peak discharge that is expected to occur within the proposed channels leading to and from the SWM Pond. The hydrologic assessment was completed by developing a hydrologic model of the Site to estimate the runoff volume and discharge rate generated for the post-development condition. The storm water modeling for the Site was conducted using software program PCSWMM 2016.

The design storm utilized in the storm water model was generated from the Campbell River Airport weather station intensity-duration-frequency (IDF) curve for the 1-25-year and 1-100-year, 24-hour storm event. A factor of safety was included in the design storm precipitation rates to account for potential changes due to climate change over the post-closure period of the Landfill.

The model provided an assessment of the sub-catchment areas, channels, and the SWM Pond under the design storms. The storm water model results are used to size the channels and ponds, determine appropriate slopes, energy dissipation measures, and recommends suitable channel linings.

Additional details of the storm water model, including inputs and model outputs are discussed in the Appendix E.

8.4 Surface Water Management Infrastructure

The sections below discuss the existing surface water infrastructure on-site, the interim measures required throughout the remaining life of the Landfill, and the proposed post-closure surface water management system. The surface water management infrastructure was designed based on the results of the hydrologic assessment discussed in Section 8.3.

8.4.1 Existing Surface Water Management Infrastructure

The existing (October 2016) surface water management infrastructure for the Site consists of:

- Two parallel ditches present along the western and northern edges of the Landfill, which convey surface water from the west to the northeast.
  - One ditch located at the toe of the slope and an outer ditch located just outside the fence line.
  - The ditches are unlined and capture the surface water from the west and north sides of the Landfill.
  - The west side ditches flow to a small pond in Block J which outlets to the surface water ditch on Argonaut Road.
- A LLDPE lined ditch is located along Argonaut Road and runs from the Site entrance gate to below the MSE wall (Argonaut Road perimeter ditch). This ditch collects water from the south side of the Landfill.
- Ditches along the top of the MSE wall collect surface water from the northeast side of the Landfill and direct it to the bottom of the MSE wall.
- Stormwater pipes located at the eastern end and the toe of the MSE wall direct water from the ditches to the roadside ditch north of Block C.

8.4.2 Operational Surface Water Management Infrastructure

As part of Landfill development, additional surface water ditches and pipes may be required. A temporary swale will be constructed along the temporary haul road, as discussed in Section 5.1.2. The post-closure surface water management infrastructure will be progressively constructed throughout the Landfill development plan, as discussed in Section 5. All surface water runoff that comes in contact with waste or daily cover will be managed as leachate.

8.4.3 Post-Closure Surface Water Management Infrastructure

The surface water management on-site at the time of closure will include the following infrastructure components:

- Haul road swale
- Mid-slope swale
- Northern Perimeter ditch
- Southern Perimeter ditch
- Surface conveyance water pipe
- SWM Pond
- Outlet Pipe and Channel

The proposed surface water management works are shown on Drawings C-03, C-04, and C-05.

8.4.3.1 Haul Road and Mid-Slope Swales

Surface water swales on the Landfill will run along the haul road and the mid-slope maintenance road. The cross-section of the swales will be trapezoidal with zero bottom width, 2H:1V side slopes, and 0.5 m depth. The haul road and mid-slope swales cross-sections are shown on Details 7 and 8, respectively on Drawing C-16.

8.4.3.2 Perimeter Ditches

The northern perimeter ditch will collect surface water from the west and north Landfill side slopes below the haul road. The northern perimeter ditch will also collect surface water from the haul road and mid-slope swales. The surface water collected will be conveyed from west to east along the western and northern edges of the Landfill. The ditch will veer to the north northeast of the Landfill and convey water toward the SWM Pond. A portion of the northern perimeter ditch will be lined with turf reinforcement matting, as shown on Drawings C-03 and C-04. The cross-section of the ditch will include a 1 m wide base, 2H:1V side slopes, and a depth of 0.5 m, as shown on Detail 4 on Drawing C-15.

The southeastern perimeter ditch commences near the Site entrance and runs northwest to the western access road. Near the access road, ditch will transition into surface water pipe that will convey the water to the northeast toward the SWM Pond. A series of small riprap lined ditches and concrete drop-down ditches are present near and on the MSE wall. These ditches convey water down to the southeastern perimeter ditch.

8.4.3.3 Conveyance Ditches and Pipes

The storm water conveyance pipe will be installed from near Argonaut road, northeast of the Landfill and convey collected surface water northwest toward the SWM Pond as shown on Drawing C-05. The pipe will be 525 mm diameter and be installed at approximately a 0.5 percent slope.

8.4.3.4 SWM Pond

The surface water flow from the Landfill will be conveyed to the SWM Pond in the northern portion of the Site on Block J. The pond will not be lined. The SWM Pond is sized to retain and infiltrate the volume of surface water runoff generated during a 1-100-year storm. The design infiltration rate from the pond is 60 mm/hr. The pond will have 3H:1V side slopes and will have an overflow outlet structure to the east, as shown on Drawing C-03.

8.4.3.5 SWM Pond Forebay

The SWM Pond entrance will consist of the sediment forebay for energy dissipation and to allow the suspended solids in the surface water flows to settle out. This will result in lower maintenance requirements in the main portion of the SWM Pond. The forebay is connected to the SWM Pond via a 'V' shaped berm, as shown on Drawing C-03.

8.4.3.6 SWM Pond Outlet

The SWM Pond outlet pipe will be constructed at an elevation of 134.5 m AMSL. Surface water will be conveyed into the outlet structure, which will allow discharge from the pond when the SWM Pond water elevation surpasses the 1-100 year elevation of 135.7 m AMSL.

9. Leachate Management Plan

The following section presents the Leachate Management Plan established for the Site including objectives, leachate quantity estimates for the pre and post closure periods for the Landfill, processes controlling leachate quality, Site operations to minimize leachate generation and leachate indicator parameters for use in the environmental monitoring program.

9.1 Leachate Management Objectives

The Site operates as a natural attenuation site for the management of leachate.

Leachate is generated by the infiltration of precipitation into the landfilled waste. Once the infiltrating water saturates the waste and sufficient pore pressures are established within the Landfill, water will discharge from the base of the Landfill in the form of leachate. As leachate migrates through the unsaturated zone, the pore space in the soils immediately beneath the Landfill becomes clogged to partially clogged as metals and dissolved solids precipitate out of the leachate and fill the pore spaces. This clogging will minimize the migration of leachate and contribute to the formation of a leachate mound within the Landfill.

Leachate migration beneath the Landfill then occurs in two stages:

- Migration in soil through the unsaturated or vadose zone
- Migration with groundwater within the saturated zone

The groundwater at the Site occurs at a minimum distance of approximately 25 m below the bottom of the waste creating a thick vadose zone. The volume of pore space in this zone, using a soil void ratio of 0.30 is approximated at 634,000 m^3.

When landfill leachate migrates through the soil and groundwater, the concentrations of the leachate constituents are reduced or attenuated by a variety of processes that include filtration, dilution, dispersion, sorption, ion exchange and biological degradation.

Significant attenuation occurs within the vadose zone although difficult to accurately quantify. When the leachate ultimately reaches the groundwater, it will migrate in the groundwater primarily through advection (in the direction of groundwater flow) and dispersion (tangential to the direction of groundwater flow) reducing in concentration as a function of distance due to the attenuation processes.

Leachate will initially disperse and migrate in the shallow portion of the groundwater and then migrate to greater depths within the aquifer as it migrates away from the Landfill.

The groundwater quality monitoring regime is designed based on site specific geology and hydrogeology strategically targeting the potential migration pathways from the Landfill.

Monitoring the rate of attenuation at the Site are one of the key objectives of the leachate management plan.

Considering the above, the primary objectives of the leachate management plan is to firstly minimize leachate generation, carry out comprehensive environmental monitoring of the attenuation processes occurring at and in the vicinity of the Site, and to reduce the potential for leachate related impacts to occur at the receiving environment.

9.2 Leachate Quantity

To estimate the current Site leachate generation rate and to determine the performance of the proposed final cover by estimating the post-closure leachate generation rate, GHD performed a leachate generation forecast using the Hydrologic Evaluation of Landfill Performance (HELP) Model. HELP is a computer assisted water balance model developed by the US Army Corp of Engineers, which relies on a quasi-two-dimensional model and is used to forecast percolation through landfills, cover systems, and other solid waste containment facilities. It is a long-accepted standard model for assessing landfill cover performance.

The HELP model incorporates climactic conditions and cover system parameters to calculate theoretical leachate generation rates. Historical normal precipitation data for 1981-2010 were used from Environment Canada Quinsam River Hatchery (Climate ID 1026639) located approximately 4 km from the Site. The following table presents a summary of the annual precipitation data:

Table 9.1 Precipitation Data – Quinsam River Hatchery

Month	Average Monthly Precipitation (mm)[1]	Average Daily Precipitation (mm)[2]	Percent Total Precipitation (%)
January	234.1	7.6	14.5%
February	160.4	5.7	9.9%
March	148	4.8	9.1%
April	101.2	3.4	6.3%
May	72.1	2.3	4.5%
June	62.8	2.1	3.9%
July	41.9	1.4	2.6%
August	49.5	1.6	3.1%
September	59.3	2.0	3.7%
October	181.3	5.8	11.2%
November	257.1	8.6	15.9%
December	250.7	8.1	15.5%
Annual	**1618.4**		**100.0%**

Notes:
1 - Environment Canada: Climate Normals - Quinsam River Hatchery (Station No. - 1026639), 1981 – 2010
2 - Average Monthly Precipitation divided by number of days per month

Current cover at the Landfill consists of daily and intermediate cover as well as approximately 5,500 m^2 of final cover constructed as part of the 2014 Phase 1 closure works, which includes an LLDPE cover system. The proposed final cover system will consist of an LLDPE liner system extending across the entire footprint of the Landfill and over perimeter surface water management ditches. The following table presents a summary of inputs utilized in the HELP modeling for each cover systems modeled:

Table 9.2 HELP Model Cover Inputs

	Topsoil	Barrier Layer	Collection/protective Layer	Geomembrane
Daily Cover	-	150 mm of Sandy Soil cover soil (k=1.0 x 10-3)	-	-
Intermediate Cover	-	300 mm of Sandy Soil cover soil (k=1.0 x 10-3)	-	-
Phase 1 Final Cover (2014)	0.3 m of Sandy, Loamy Soil (k=1.7 x 10^{-3})	-	0.3 m of gravel (k=3.0 x 10^{-1}) underlain by geotextile protective layer	1.5 mm LLDPE (k=2X10^{-13})
Planned Final Cover	0.15 m of Sandy, Loamy Soil (k=1.7 x 10^{-3})	0.6 m of Sandy Soil cover soil (k=1.0 x 10^{-3})	5 mm geocomposite drain (k=1.0X10^{1})	1.5 mm LLDPE (k=2X10^{-13})

The model was developed for both plateau and side slope areas of the Landfill mound. Based on topographical information, approximately 77% of the landfill footprint is currently sloped at 3H:1V (side slopes). Under proposed final conditions, approximately 97% of the landfill footprint will be sloped to 3H:1V (side slopes). The leachate migration through the thick waste layer and interface soil layer immediately beneath the waste was modelled to estimate the potential of migration of leachate beneath the Landfill.

The current leachate generation rate for the Landfill is estimated to be 87,950 m^3 per year. This generation rate will decrease as each stage of the Landfill is completed and the placement of intermediate cover is completed. The installation of the proposed final cover system as designed herein will significantly reduce leachate generation to approximately 10 m^3 per year. The final cover is an important element of the leachate management plan. The HELP model inputs and outputs are presented in Appendix F.

9.3 Leachate Minimization

Leachate generation resulting from the infiltration of precipitation into the waste prior to the closure of the Landfill will be minimized by:

- Minimizing the size of the active disposal face to minimize infiltration. The current waste discharge rate is approximated at 100 tonnes per day. Assuming a 1.0 m thick lift, the active face should be maintained less than 200 m^2 and covered with daily cover at the end of each operating day.
- Constructing to final contours to optimize progressive placement of intermediate cover. Active discharge areas of the Landfill within each landfilling Stage should be constructed to final

design elevations to the extent practical to allow for placement of intermediate cover. Short-term fill plans should be developed on a continual basis by the Site operator.

- Promotion of clean surface water diversion away from the active face and into surface water management ditches and ponds. Once surface water comes into contact with waste or daily cover it must be managed as leachate and contained with berms and infiltrated. Minimizing the surface water containment/infiltration area and preventing clean surface water from flowing into the containment area reduce infiltration.

Upon closure of the Landfill, the geo-membrane final cover will be placed over the entire Landfill. The geomembrane final cover will eliminate infiltration and leachate generation at the Site.

Ongoing monitoring of the surface water run-off and the groundwater quality within overburden aquifer beneath and downgradient of the Site will be used to ensure that the Site operations are meeting the leachate management plan objectives. If changes in the groundwater quality warrant adjustments to the Site operations to further reduce leachate generation, recommendations will be made in the annual operations and monitoring report and implemented as a corrective action plan.

9.4 Leachate Composition

Principle factors affecting the composition of leachate include (McBean et al., 1995):

- Waste composition
- Age of refuse
- Landfill operations
- Climatic conditions
- Hydrogeological conditions
- Conditions within the landfill (e.g. chemical and biological activities, temperature, pH, and redox conditions)

The mass of refuse stored in a landfill represents a finite source of pollutants. Typical MSW leachate is a mixture of organic and inorganic compounds produced from refuse materials by a combination of physical, chemical and biochemical processes. Landfill leachate constituents typically include organics, nitrogen, phosphates, heavy metals, dissolved solids.

Physical processes, related to leachate generation, involve the flushing and dissolution of water as it percolates through the refuse material. The mass of pollutants available for leaching is largely a function of the physio-chemical nature of the waste, the extent of waste stabilization, and the volume of infiltration into the landfill (Lu et al., 1984).

Chemical processes, including ion exchange, sorption/desorption, and change in pH, contribute to leachate production by enhancing the mobilization of various leachate constituents.

Biological processes contribute to leachate production via the degradation of organic constituents within the waste into simpler and more mobile compounds. Biological degradation generally involves aerobic and anaerobic phases, which can occur simultaneously and have varying impacts on leachate chemistry.

In general, when refuse is landfilled in an active landfill cell the initial biodegradation phase occurs under aerobic conditions resulting in the partial degradation of organic components in the refuse material. The aerobic decomposition typically results in high carbon dioxide (CO_2) concentrations, a lowering of pH and an increase in temperature, chemical oxygen demand (COD), biochemical oxygen demand (BOD), and specific conductance levels in leachate.

As the availability of oxygen is limited, the organic material will undergo anaerobic decomposition. In the beginning of this anaerobic phase, generally elevated levels of organic acids, ammonia, hydrogen and carbon dioxide are produced. The production of organic acids and carbon dioxide can lower the pH in the leachate, enhancing the dissolution of inorganic constituents including iron (Fe), magnesium (Mg), zinc (Zn) and calcium (Ca). This phase is also characterized by elevated levels of BOD, COD, and specific conductance. However, as the degradation of organics into simpler and more mobile compounds continues, lower BOD levels will be reached and the pH will stabilize. Inorganic elements such as sulphate, chloride, iron, sodium and potassium, however, can continue to leach and dissolve for a prolonged period of time.

It should be noted that in anaerobic conditions, the three most important bacteria capable of degrading organics include Iron(III)-reducing (Fe(III)-reducing bacteria), sulphate-reducing, and methanogenic bacteria. The Fe(III)-reducing bacteria oxidate organic matter with the reduction of Fe(III), sulphate-reducing bacteria oxidize organic matter by reducing sulphate and producing hydrogen sulphide, while methanogenic bacteria convert organic matter to carbon dioxide and methane. Typically these bacteria are not active simultaneously, thus no hydrogen sulphide or methane production occurs until the Fe(III) reduction is complete and no methane production occurs until sulphate is depleted (Lovley, 1987). In other words, Fe(III)-reducing bacteria can out compete both sulphate-reducing and methanogenic bacteria for fermentable substrates until Fe(III) becomes depleted, then sulphate-reducing bacteria can out compete methanogenic bacteria for organics until sulphate is depleted.

Anaerobic conditions can occur within the waste during landfilling, but are generally more ideal after closure. Over time, generated leachate typically decreases in "strength" or chemical concentration as a result of "washout" (i.e., tendency of contaminants to be transported away from the Site by infiltrating water) (Reinhart, 1995).

9.5 Leachate Indicator Parameters

Leachate indicator parameters and concentrations are identified for purposes of water quality monitoring in order to monitor for the presence of leachate, assess the rate of attenuation and to provide a comparison of groundwater monitoring data to background water quality. Leachate indicator parameters are compounds, which are highly soluble and are subject to minimal attenuation to signal the early movement of a leachate plume.

Leachate indicators for the Site have been identified based on their low attenuation potential and common presence in MSW leachate. Site-specific leachate chemistry data is not available as the base of the waste is above the underlying aquifer and no monitoring wells screened within the waste are present at the Site. Typical leachate indicator parameters concentrations have been determined based on monitoring data from similar municipal landfills (CRA, 2015 and CRA, 2014), and literature values (Dydo et. al., 2005 and US EPA, 1986).

The following table summarizes leachate parameters and their respective concentrations currently used for comparison to groundwater quality data:

Table 9.3 Typical Leachate Indicator Parameter Concentration Ranges

Parameter	Concentration
Alkalinity (mg/L)(1)	71 – 3,340
Ammonia (mg/L)(1)	84.3 – 449
Boron (µg/L)(1)	3,200 – 4,680
Chloride (mg/L)(1)	150 – 506
Conductivity (uS/cm)(1)	161 – 8,126
Iron (µg/L)(1)	940 – 40,440
Hardness (mg/L)(2)	0.1 - 36,000
Manganese (µg/L)(1)	1,250 - 7,250
pH(2)	3.5 - 8.5
Sulphate (mg/L)(2)	25 – 500
Total Suspended Solids (mg/L)(3)	30-1150
Biological Oxygen Demand (mg/L)(3)	20-65
Notes: (1) CRA, 2015 (2) Dydo et. al., 2005 and US EPA, 1986 (3) CRA, 2014	

To identify Site specific leachate indicator parameters, groundwater quality from the background monitoring wells is compared with groundwater quality at the monitoring wells screened within the overburden aquifer at the downgradient boundary of the Landfill Footprint. The table below summarizes the 2016 groundwater quality data for the background monitoring locations and the downgradient edge of the Landfill Footprint monitoring locations.

Table 9.4 Overburden Aquifer Leachate Indicator Parameter Concentrations

Parameter	Alk. (mg/L)	NH_4 (mg/L)	Bo (µg/L)	Cl^- (mg/L)	Cond. (µS/cm)	Hardness (mg/L)	Fe (µg/L)	Mn (µg/L)	pH (S.U)	SO_4 (mg/L)
Typical MSW Leachate	71-3,340	84.3-449	3,200 – 4,680	150 – 506	161 – 8,126	0.1-36,000	940-40,440	1,250-7,250	3.5-8.5	25-500
HBT94-3 (toe of landfill footprint, shallow)	312-372	19.3-150	372-604	31-58	808-822	221-248	3,060-3,730	2,100-2,120	6.94-6.98	ND-2.39
HBT94-1 (toe of landfill footprint, shallow)	191-278	0.47-4.0	146-224	17-45	446-669	164-289	5.5-617	985-2,810	6.11-7.19	3.72-6.00
HBT94-2 (toe of landfill footprint, deep)	280-791	1.02-3.5	146-803	25-95	593-1,600	267-835	343-2,010	1,720-6,300	6.85-7.85	3.52-4.87
MW01-16 (background)	37.9-41.2	ND-0.028	ND	ND-0.97	86.9-91.2	39.3-44.3	ND-6.6	1.4-22.3	6.91-7.55	2.71-3.63

Parameter	Alk. (mg/L)	NH_4 (mg/L)	Bo (µg/L)	Cl^- (mg/L)	Cond. (µS/cm)	Hardness (mg/L)	Fe (µg/L)	Mn (µg/L)	pH (S.U)	SO_4 (mg/L)
AM02-01 (background)	40.2	ND	ND	1.7	88.4	40.6	ND	ND	6.86	6.86

ND – Parameter concentration below laboratory detection limit, Alk: alkalinity, NH_4: Ammonia, Cl^-: chloride, SO_4: sulphate, Cond: Conductivity

Concentration ranges based on results of 2016 Environmental Monitoring Plan (GHD)

From review of the table above, chloride, conductivity, hardness, manganese, and alkalinity levels have the highest variance in groundwater quality between the background monitoring wells and downgradient edge of the Landfill Footprint monitoring wells. Boron, iron, and ammonia levels also show some variation in groundwater quality. Sulphate and pH levels show minimal variation in groundwater quality and as such therefore, they are not appropriate leachate indicator parameters for the Site.

Based on the above water quality comparison, the following Site specific leachate indicator parameters identify the presence of leachate in water and are to be monitored in groundwater and surface water migration pathways at and in the vicinity of the Site:

- Chloride
- Conductivity
- Manganese
- Hardness
- Alkalinity

As presented in Section 13, the environmental monitoring program will continue to be expanded on a phased approach that is reactive to the water quality monitoring results and monitor for potential leachate impact to the receiving environment.

10. Landfilling Gas (LFG) Design Plan

10.1 LFG Production

LFG is primarily generated as a result of biological decomposition of organic waste material. The processes involved in biological decomposition of solid waste are highly variable. In the early stages of decomposition (typically less than two years after initial placement), microbial activity is oxygen consuming (aerobic). This results in relatively high in-situ temperatures, production of gases composed primarily of carbon dioxide (CO_2) with other trace compounds, and production of acidic leachate.

As the oxygen in the solid waste mass is consumed, activity of anaerobic microbes increases and eventually results in production of LFG that is predominantly methane (CH_4) and CO_2, and in some cases hydrogen sulphide gas (H_2S). In this phase of the decomposition, the in-situ temperatures are typically in the range of 30 to 40° C and the leachate has a more basic pH. This methanogenic

phase of decomposition will reach an equilibrium level, which will continue for some length of time. The equilibrium condition and the duration of methanogenic decomposition are the primary determinants of the LFG production over time. Within a few years, this anaerobic Stage typically becomes and remains dominant until all organic matter in the Landfill has been fully decomposed. The typical LFG production stages are illustrated in Figure 10.1.

These processes are dependent upon the following primary parameters:

- Age of solid waste
- Quantity of solid waste
- Solid waste composition
- Moisture content
- Density and filling practices
- Climate (i.e., precipitation and temperatures)
- Landfill chemistry

This list serves to illustrate the complexity of the processes involved in the production of LFG. The solid waste age, quantity, and composition, along with site moisture content are considered the primary influences on the rate and duration of LFG production.

The composition and quantity of the solid waste placed in a landfill will determine the amount of material available for decomposition. Materials with a higher organic content are more readily decomposable than those wastes with a low or no organic content. For example, food and agricultural wastes contribute more readily to LFG production than construction rubble. In general, waste that is derived from residential sources contains a higher decomposable fraction than those derived from other sources.

Collected LFG may contain varying amounts of nitrogen (N_2) and oxygen (O_2) due to intrusion of outside ambient air into the landfill. The typical composition of the gas may be in the following range depending on the operation of the LFG collection system:

- CH_4– 35 to 60 % by volume
- CO_2– 35 to 60 % by volume
- O_2 – 0 to 5 % by volume
- N_2 – 0 to 15 % by volume

For modelling and design purposes, the composition of LFG produced and collected is assumed to be 50% CH_4 and 50% CO_2, each by volume.

The optimal range of moisture content in refuse for methane production is reported to be 40 to 70% by weight (Reinhart & Townsend, 1998). Actual LFG production is sensitive to moisture; however, the degree of moisture distribution and saturation within the landfill are difficult to determine. Furthermore, there are various technical difficulties in ensuring adequate leachate distribution and collection within a landfill.

Due to the complexity of the processes involved in LFG production, the methods available to predict variations in production over the life of a site provide only estimates to permit the design of control systems. Flexibility to address changes in the LFG production should always be a primary design consideration in any LFG management program.

The use of predictive models provides the best method of defining a particular site's LFG generation potential.

10.2 Regulatory Criteria

With respect to LFG generation at a MSW landfill, the BC MOE Landfill Gas Management Regulation (LFG Regulation) requires the following:

- Landfills receiving over 10,000 tonnes of waste per year, or landfills that have over 100,000 tonnes of waste in place, complete a LFG generations assessment at least every five years.
- The assessment of the forecasted LFG generation rate in the year of the assessment and for the next five years be prepared by a qualified professional and submitted to the MOE.
- If the landfill is currently generating over 1,000 tonnes of methane per year, according to the LFG generation assessment, then a LFG design plan must be submitted to the MOE within one year.
- Once the LFG design plan is accepted, an active landfill gas collection system is required to be installed within four years of the LFG design plan acceptance.

In addition, the Landfill Criteria requires that:

- Soil gas concentrations at the landfill site boundary must not exceed the lower explosive limit (LEL) of methane (5 percent by volume) at any time.
- Combustible gas concentrations measured in on-site buildings must not exceed 20 percent of the LEL of methane (1 percent by volume) at any time.

10.3 Previous Reports and Assessments

In 2008, CH2MHILL prepared a LFG assessment for the Site (CH2MHILL, 2008).

In 2010, Conestoga-Rovers & Associates (CRA) prepared an updated LFG assessment for the Site (Conestoga-Rovers & Associates, 2010) to meet requirements of the LFG Regulation. The 2010 LFG Assessment identified that the Site had over 100,000 tonnes of waste in place and was producing more than 1,000 tonnes of methane per year and therefore, as required by the LFG Regulation, a LFG collection system design was recommended for completion prior to January 1, 2012.

In 2013, SCS Engineers prepared a Landfill Gas Management Facilities Design Plan for the Site on behalf of the CSWM (SCS Engineers, 2013)(2013 LFG Plan). The 2013 LFG Plan was developed to fulfill requirements of Section 7(2) of the LFG Regulation. LFG Plan was submitted to the MOE in 2013.

In 2017, GHD prepared an Updated Landfill Gas Management Facilities Design Plan (attached as Appendix G) (2017 Design LFG Plan). The 2017 LFG Plan was developed to simplify the design and to reduce the implementation costs. The LFG Plan will be implemented upon the closure of the Landfill.

10.4 LFG Control

The following section presents a summary of the planned LFG infrastructure included in the 2017 LFG Design Plan. Further details of the LFG system as well as LFG generation forecasts are presented in the LFG Design Plan attached as Appendix G. The LFG infrastructure will consist of:

- Vertical LFG collection wells and buried pipe network
- Enclosed flare
- LFG instrumentation (methane and oxygen sensors, flow meter)
- Condensate management
- Programmable logic controller (PLC) and data logger

Collection of operational data of the LFG collection system will also be conducted throughout the operation of the system. The LFG system infrastructure will be constructed as part of the final cover works for the Landfill.

10.5 LFG and Safety

As indicated in Section 10.1, LFG is produced primarily due to biological decomposition, generating CO_2 and CH_4. Predominantly due to pressure gradients, LFG migrates through either the landfill cover or adjacent soil and enters the atmosphere, contributing greenhouse gas (GHG) emissions, creating health and toxicity issues, and creating nuisance odours. These impacts are largely dependent upon the pathway by which humans and the environment are exposed.

Sub-surface migration of LFG is influenced by pressure differentials within the waste mass, LFG migration from areas of high pressure to areas of low pressure, diffusion of LFG from areas of high concentrations to low concentrations, and the permeability of the waste, liner, and cover systems.

Sub-surface migration of LFG poses two primary concerns related to the accumulation of gases within or below structures near the Landfill. First, accumulation of LFG in a subsurface structure (i.e., basement, buried manhole, etc.) may expose those required to enter the structure to an oxygen deficient environment. Second, accumulation of LFG introduces the risk of an explosion if a source of ignition is present. The risk of explosion occurs when the concentration of methane in air exceeds its Lower Explosive Limit (LEL). Due to the fact that the LEL of methane is approximately 5% by volume in air, only a small proportion of LFG (containing approximately 50% methane by volume) is necessary to create explosive conditions.

Visual observation of the sub-surface migration of LFG is possible through identification of areas impacted by vegetative stress. Vegetative stress occurs due to the displacement of oxygen in the soil and the resultant oxygen deprivation of the plant roots. Deterioration of vegetation on or near landfills may be both an aesthetic and a practical issue. In areas where vegetative cover is

diminished, erosion of the cover may occur. This may result in a "cascade" effect resulting in increased LFG emissions.

H_2S, if present, presents immediate danger to the health and safety of workers. WorkSafeBC regulations and guidelines must be followed. At a minimum, the following procedures are recommended, if the potential for H_2S becomes an issue.

- No persons shall traverse or operate equipment within the limit of waste or in the vicinity of the leachate management infrastructure without wearing a 4-gas meter.
- All leachate collection system cleanout and sump riser pipe blind flanges should be completely sealed, bolted, locked, and identified with appropriate signage.
- Appropriate measures should be taken to prevent persons untrained in H_2S safety and without the appropriate personal protective equipment from entering the site. Appropriate signage should be installed around the limit of waste.
- Appropriate chain link fencing and signage should be installed around any area that may have H_2S present (Hot Zone).
- All workers and contractors working in designated Site Hot Zones, if applicable, should be required to have completed the H_2S Alive course.
- All workers and contractors working on-site should be required to have reviewed and acknowledged the Site health and safety plan which discusses the H_2S safety plan and restricts smoking anywhere onsite.

10.6 LFG Monitoring and Assessment

The highly permeable overburden unit at the Site may allow the LFG to migrate away from the Landfill. The highest migration potential occurs during the winter months when snow and ice can form an impermeable blanket across the ground surface. It is therefore recommended that the potential off-Site LFG migration be monitored at the periphery of the Site, and into the existing buildings currently occupied by the operational personnel. The soil gas concentrations at the Landfill boundary must not exceed the lower explosive limit of methane (five percent by volume). The soil gas concentrations in on-Site buildings must not exceed 20 percent of the lower explosive limit of methane (one percent by volume) at any time.

11. Contaminating Lifespan Assessment

The contaminating lifespan (CLS) is the period of time after final closure of the Landfill that is required for leachate parameters from the Landfill to sufficiently decay such that the quality of the leachate meets the applicable BC CSR water quality standards, as discussed in Section 13.2.1. At the end of the CLS the leachate no longer poses an environmental risk to the receiving environment. The CLS is used to determine the length of the post-closure environmental monitoring program, as discussed in Section 13. This Section presents the CLS Assessment for the Site. The CLS Assessment may be updated as required based on available data.

It is noted that landfilling began at the Site in 1970 and the waste composition landfilled prior to the CVRD ownership, in 1999, is relatively unknown. GHD understands that the waste landfilled in the early life of the Landfill is further along in the decay process and may be nearing the end of its CLS, however the calculations completed for this CLS Assessment are unable to take this into account.

The CLS of the Site was estimated using a first order decay function. Completing the first order decay function is not possible for all leachate indicator parameters as decay constants have not been developed for all of the common leachate indicator parameters such as iron and manganese (Lu et al, 1981). Due to this limitation, the parameters selected to estimate the CLS include chloride, alkalinity, and ammonia. Chloride, alkalinity, and ammonia have also been identified as key leachate indicators for the Site, based on groundwater monitoring activities conducted by GHD (GHD, 2017). Chloride was selected as it only decays through dissolution. Alkalinity and ammonia were selected to perform a check of the chloride decay rate, however it should be noted that alkalinity and ammonia may be subject to biological influence.

11.1 First Order Decay Model

Leachate indicator parameter degradation was simulated utilizing the 1DTRANSEN model. The leachate source concentration in the one-dimensional transport model is governed by the time function.

$$C_0 = \begin{cases} (t/t_1)C_B + C_A & 0 < t < t_1 \\ C_B & t_1 \le t < t_2 \\ C_B e^{-\lambda t} & t \ge t_2 \end{cases}$$

Where:

C_0 = Parameter concentration at time of sufficient degradation

C_A = Parameter concentration prior to landfilling

C_B = Parameter concentration at Site closure

t = Simulation time

t_1 = Time landfilling commences

t_2 = Time of Site closure

λ = Decay constant

For the purpose of this assessment, GHD focused on the post closure period (i.e. $t \geq t_2$). When the simulation time is greater than t_2, the source concentration is assumed to decay exponentially at a rate of λ, the first order decay constant. The concentration at Site closure, C_B, was estimated for each constituent of concern (COC), based on leachate data from existing landfills that accept a similar waste stream as the Site.

11.1.1 Estimated Leachate Concentrations

Concentrations of the leachate parameters used in this CLS assessment were estimated based on leachate data from existing similar landfills as there is no Site-specific leachate data available at this time. GHD compiled data from several similar landfills and used both the mean and maximum concentrations for each leachate parameter to complete two CLS estimates for the selected leachate parameters. The CLS estimate using the mean concentration provides a conservative estimate and the CLS estimate using the maximum concentration provides a "worst case scenario" estimate.

11.1.2 Results

The First Order Decay Method estimates the CLS for each constituents of concern identified for the Site. The CLS is measured by years for each constituent to decay to meet the applicable CSR water quality standards or to return to background groundwater conditions. Table 11.1 below provides a summary of the results of the CLS Assessment; the supporting calculations are provided in Appendix H.

Table 11.1 Contaminating Lifespan Estimate Results

Parameter	Years to Meet CSR DW Standards (mean estimate)	Years to Meet CSR DW Standards (worst case estimate)	Years to Meet Background Groundwater (mean estimate)	Years to Meet Background Groundwater (worst case estimate)
Chloride	9	42	-	-
Ammonia	50	66	-	-
Alkalinity	-	-	49	65

11.2 Summary

The CLS of the Site was estimated using the First Order Decay Method to determine the time period required after the Site closure for the concentration of select leachate constituents to reach the applicable water quality criteria. The First Order Decay Method determined that the mean concentration time period and "worst case" time period estimates for chloride to decay to meet CSR drinking water (DW) standards is 9 years and 42 years, respectively. As stated in Section 7.4 of the Landfill Criteria, estimated contaminating lifespans less than 30 years are not permitted, therefore the mean concentration estimate for chloride of 9 years should not be considered valid.

Using the First Order Decay Method, GHD determined that the mean concentration time period and "worst case" time period estimates for ammonia to decay to meet CSR DW standards is 50 years and 66 years, respectively.

Using the First Order Decay Method, GHD determined that the mean concentration time period and "worst case" time period estimates for alkalinity to decay to meet become similar to background groundwater conditions at the Site is 49 years and 65 years, respectively.

12. Closure Plan and Post Closure Period

The following section presents the operations plan for the Site for the post-closure period of the Landfill.

12.1 Post Closure Site Conditions

At the approximate time of the final closure of the Landfill, the Site will be transitioned to a transfer station with a closed Landfill. The transfer station will be used for the collection of waste from the Campbell River wasteshed and transfer to the CVWMC. The remainder of the Site will be occupied by the closed Landfill, access and maintenance roads, surface water management ditches and pond, environmental monitoring infrastructure and LFG collection and flaring infrastructure. The Site, excluding the waste transfer station, will remain closed to the public for the post-closure period to protect public safety and prevent damage to Site infrastructure.

12.2 Post Closure Period

The post-closure period is defined by the Landfill Criteria as the period of time from installation of final cover over the entire Landfill to the end of the contaminating Lifespan. The CLS for the Site was estimated in Section 11 to be 65 years.

12.3 Site Environmental Monitoring

The post-closure environmental monitoring program for the Site is described in Section 13.0 and will include the following:

- Hydraulic monitoring of groundwater levels
- Sampling and chemical analysis of surface water, groundwater, leachate and LFG
- General site inspections for settlement, erosion, and vegetative stress

The post-closure monitoring program will continue for the duration of the post-closure period. As the Site conditions relative to the quantity and quality of surface water and groundwater stabilize and become predictable under post-closure conditions, amendments to the environmental monitoring program may be warranted. Any proposed amendments to the long-term environmental monitoring program will be submitted to the Director for review and approval prior to implementation.

12.4 Surface Water Control

The strategy outlined in the surface water management plan in Section 8.0 will be maintained at the Site during the post-closure period to manage and control surface water flows. The mid-slope swales, ditches, and SWM Pond will be designed to for the post-closure period. Channels with steep slopes will require erosion protection, as discussed in the Section, 8.0.. Ditches, SWM Pond, forebay pond and inlet and outlet structures will require reassessment upon Landfill closure to ensure that they are functioning satisfactorily. Vegetation will be maintained on the Landfill surface to control erosion and promote evapotranspiration, and in the channels to ensure channels maintain their design capacity. Surface water management infrastructure will be inspected annually and

damage will be noted and repaired as required. The surface water management works including ditches, swales, culverts, pipes, and sediment forebay and SWM Pond monitored and maintained as required.

12.5 Final Cover

The final cover will be inspected at least annually and vegetation will be managed (cut, removed or restored as required) at least twice annually or more often as required to prevent damage via the growth of deep rooting plants. Inspection should include identification of any exposed areas of geocomposite drain or LLDPE, to ensure that no significant damage has occurred due to plant growth, sloughing of the cover, or significant settlement. Damage observed will be noted and repaired as soon as practical.

12.6 LFG Management System

The LFG management system including collection infrastructure and flare will operate after closure. The operational life of the LFG management infrastructure will be determined based on reduction in methane generation rates, but will be assumed to be not less than the post-closure period unless operational data indicates that methane concentrations are reduced to a level which warrants the cessation of the flare operation (typically less than 100 cubic metres per hour LFG collection rate). Post-closure period operation of LFG infrastructure will include operation, maintenance and repair (as needed). Details on infrastructure operation, inspection and maintenance are presented in the LFG Management Plan attached as Appendix G.

12.7 Site Access Roads and Fencing

Site access roads will be maintained post-closure to ensure safe access by monitoring and maintenance staff and to facilitate any required maintenance. Site access roads will be inspected annually and repaired as required to ensure safe access to the Site.

Site fencing will be maintained and/or replaced to prevent unauthorized entry to the Site and potential damage to Site infrastructure. Upon closure, the bear fence will be decommissioned and replaced with a suitable fence to prevent public entry. Fenced areas will include, at a minimum, the Landfill, the LFG flare and associated above ground infrastructure, and the SWM Pond.

13. Environmental Monitoring Program

The purpose of the EMP is to monitor the quality of leachate, groundwater and surface water, and to monitor for the presence of LFG at, and in the vicinity of the Site. The EMP will detect actual and/or potential landfill-derived impacts to the receiving environment, if occurring. The scope of EMP for the Site has been developed with consideration of the requirements outlined in the following documents:

- Landfill Criteria
- Environmental Monitoring Guidelines

- The OC
- 2016 Operations and Monitoring Report (GHD, 2017) (2016 Annual Report)

The EMP is Site specific and is based on Site geology, hydrogeology, leachate indicator parameters and previous monitoring results. Environmental monitoring data for the Site is available beginning in 1993. The following section presents a summary, rationale and recommendations for the EMP. Further details on current and historical environmental data including regulatory compliance and trends are presented in the 2016 Annual Report.

13.1 Leachate Monitoring

As indicated in Section 9.1 of the Landfill Criteria, the purpose of a landfill's leachate monitoring program is to determine the site-specific leachate indicator parameters to ensure they are included in the groundwater and surface water monitoring program.

The Landfill was developed as a natural attenuation landfill; therefore leachate sample collection is not possible, as no leachate collection system is in place at the Site. In addition, no leachate wells currently exist at the Site. Groundwater monitoring well EBA04-4 is located within the Landfill Footprint, however it is screened approximately 30 metres below the waste and groundwater is encountered approximately 25 metres below the waste at this location. Based on these observations, monitoring well EBA04-4 is not suitable to be used as a leachate well.

Leachate indicator parameters have been identified for the Site, based on common leachate indicator parameters and groundwater quality results. Site specific leachate indicator parameters have been identified (Section 9.5) by comparing groundwater quality at the background monitoring wells (AM02-01 and MW01-16) to the groundwater quality at the monitoring wells screened within the overburden aquifer at the downgradient edge of the Landfill Footprint (HBT94-1/HBT94-2/HBT94-3).

At this time, the installation of leachate wells is not warranted as at appears that monitoring wells HBT94-1/HBT94-2/HBT94-3 provide sufficient water quality data to determine the Site-specific leachate indicator parameters.

13.2 Groundwater

This section details the current groundwater monitoring program conducted at the Site and proposed expansion to the groundwater monitoring program to address existing information gaps.

13.2.1 Groundwater Quality Performance Criteria

Groundwater quality at the Site, as requested by the Director, is compared to the BC CSR generic numerical water quality standards (including amendments up to B.C. Reg. 253/2016, November 1, 2017). The following BC CSR water quality standards are applied to the Site as per Protocol 21 for Contaminated Sites – Water Use Determination (MOE, 2017):

- Schedule 3.2 Column 3 Aquatic Life, Freshwater
- Schedule 3.2 Column 6 Drinking Water

13.2.2 Current Groundwater Monitoring Program

The groundwater monitoring program consists of both hydraulic monitoring (water levels) and groundwater sampling for field and laboratory analysis. The groundwater monitoring program includes 14 monitoring wells on-Site and seven monitoring wells off-Site. The wells are classified as background (upgradient), Landfill wells, and downgradient, as well as deep overburden or shallow overburden. The existing groundwater monitoring wells locations are shown in Figure 13.1, and include the following wells:

- Background wells: AM02-01, MW01-16
- Landfill wells, located within the Landfill Footprint or very close to the Site property line.
  - Shallow overburden: EBA04-7, HBT94-1, HBT94-3
  - Deep overburden: EBA04-1, EBA04-4, EBA04-6, HBT94-2
- Downgradient wells located east of the Landfill Footprint:
  - Northeast downgradient shallow overburden: AG99-06, EBA11-1, EBA11-2, EBA11-3, EBA11-4, GLL93-4
  - Northeast downgradient deep overburden: EBA04-3
  - Southeast downgradient shallow overburden: HBT94-5
  - Southeast downgradient deep overburden: AG99-01, AG99-02, AG99-04, AG99-05

Groundwater samples are collected quarterly and are analyzed for general chemistry parameters, nutrients, and dissolved metals. Groundwater samples are collected from select groundwater monitoring locations for analysis of volatile organic compounds (VOCs) on a semi-annual basis. Appendix I provides a water quality monitoring program summary for groundwater at the Site.

13.2.3 Groundwater Monitoring Program Amendments

Amendments to the groundwater monitoring program includes expansion of the monitoring well network. Additional monitoring wells are to be installed in a phased approach to address identified information gaps on a priority basis.

Currently the phasing for additional monitoring wells are illustrated on Figure 13.1 and includes:

- Two monitoring wells (MW02 and MW03) in the shallow portion of the overburden aquifer, southeast of the Landfill Footprint
- One monitoring wells (MW04) in the shallow portion of the overburden aquifer, in Block J east of the SWM Pond
- Two monitoring wells (MW06 and MW07) in the shallow portion of the overburden aquifer, southeast of the Landfill Footprint
- One monitoring well (MW08) in the deep portion of the overburden aquifer, nested with existing monitoring well EBA11-1

Table 13.1 below presents the estimated screen depth and rationale for each proposed monitoring well.

Table 13.1 Proposed Groundwater Monitoring Locations Summary

Groundwater Monitoring Location	Estimated Screen Depth (mBGS)	Rationale
MW02	25 – 30	To provide shallow groundwater quality data downgradient of HBT94-1/HBT94-2/HBT94-3 as the presence of leachate has been observed at these monitoring locations (GHD, 2017). The presence of leachate is more pronounced within the shallow portion of the overburden aquifer (GHD, 2017). The current groundwater monitoring program does not monitor groundwater quality in the shallow portion of the overburden aquifer southeast of the Site as HBT94-5 has been dry since 2000. MW02 is scheduled for installation in 2018.
MW03	20 – 25	To provide shallow groundwater quality data downgradient of the southeastern boundary of the limit of waste. This location will be screened in the shallow portion of the overburden aquifer nested with AG99-05 is screened approximately 30 metres below the top of the water table. MW03 is scheduled for installation in early 2018.
MW04	30 – 35	To provide shallow groundwater quality data immediately downgradient of the SWM Pond to be constructed in Block J. MW04 will provide information necessary to monitor for potential impacts resulting from surface water infiltration. MW04 is scheduled for installation in 2019.
MW06	22 – 27	To provide shallow groundwater quality data downgradient of the southeastern boundary of the limit of waste. This location will be screened in the shallow portion of the overburden aquifer nested with AG99-02. AG99-02 is screened approximately 25 metres below the top of the water table. MW06 is scheduled for installation in 2020/2021.
MW07	20 – 25	To provide shallow groundwater quality data downgradient of the southeastern boundary of the limit of waste. This location will be screened in the shallow portion of the overburden aquifer nested with AG99-04. AG99-04 is screened approximately 25 metres below the top of the water table. MW07 is scheduled for installation in 2020/2021. MW03/AG99-05, MW06/AG99-02, and MW07/AG99-04 will provide well nests that are oriented in a line that runs parallel to and downgradient of the Site's southeastern property boundary.

Groundwater Monitoring Location	Estimated Screen Depth (mBGS)	Rationale
MW08	35 – 40	Provide deep groundwater quality data downgradient of nested wells EBA04-6/EBA04-7, The current groundwater monitoring program may not adequately monitor the deeper portion of the overburden aquifer northeast of the Site. MW08 is scheduled for installation in 2020/2021.

13.3 Surface Water

This section details the current surface water monitoring program conducted at the Site and proposed amendments to the surface water monitoring program.

13.3.1 Surface Water Quality Performance Criteria

Surface water quality, as requested by the Director, is compared to the BC CSR generic numerical water quality standards. The following BC CSR water quality standards are applied to the Site as per Protocol 21 for Contaminated Sites – Water Use Determination (MOE, 2017):

- Schedule 3.2 Column 3 Aquatic Life, Freshwater
- Schedule 3.2 Column 6 Drinking Water

Surface water quality, as requested by the Director, is also compared to the BC Approved Water Quality Guidelines (MOE, 2017) and the BC Working Water Quality Guidelines (MOE, 2017) . The Drinking Water guidelines and Freshwater Aquatic Life guidelines are applied to surface water quality at the Site.

13.3.2 Current Surface Water Monitoring Program

Surface water monitoring locations are located downstream from the Site as shown in Figure 13.1. The current surface water monitoring program includes sampling of three surface water monitoring locations as follows:

- SW-1 is located on an ephemeral tributary of Cold Creek.
- SW-2 is located approximately 750 m north east of the Site on an ephemeral pond, which at times is linked to a tributary of Cold Creek.
- SW03-17 is located on an unnamed pond located upstream of SW-1. SW03-17 was added to the Site's surface water monitoring program in 2017, as recommended in the 2016 Annual Operations and Monitoring Report to provide additional surface water quality data as SW-1 and SW-2 are often dry in the summer months.

Surface water samples are collected quarterly and are analyzed for various general chemistry parameters, nutrients, and total and dissolved metals. Appendix I provides a water quality monitoring program summary for surface water at the Site.

13.3.3 Surface Water Monitoring Program Amendments

Following the construction of additional surface water management infrastructure at the Site during the Site closure period, the addition of new sampling locations in Site's drainage ditches and/or SWM Pond may be required.

13.4 LFG Monitoring

LFG monitoring is required to ensure the health and safety of the Site staff, users of the Site and the public. The LFG monitoring will be conducted annually using subsurface probes, consistent with the BC LFG Management Facilities Design Guidelines (MOE, 2010), Section 6 of the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, and Sections 4.2 and 9.3 of the Landfill Criteria.

Soil gas probes should be established at the west and north property boundaries and along Argonaut Road to monitor for the migration of methane in soil gas. The on-Site offices, scalehouse and other enclosed buildings should be equipped with methane gas sensors that notify occupants if methane concentrations reach 10 percent of the lower explosive limit of methane (0.5%).

14. Fire Safety and Emergency Contingency Plan

A Fire Safety and Emergency Contingency Plan has been developed for the Site in accordance with the BC Occupational Health and Safety Regulation 296/97 Part 4, S.4.13 - 4.18 (Emergency Preparedness and Response) and Part 5, s.5.97 - 5.102 (Emergency Procedures), as well as Section 2.8 of the BC Fire Code. The Fire Safety and Emergency Contingency Plan must be submitted to the appropriate fire authority(ies), the responding fire department(s), the Director, and the City initially and upon the completion of significant changes.

A copy of the Fire Safety and Emergency Contingency Plan is provided in Appendix J. This plan must be reviewed and updated at least once annually.

15. Contingency Measures

As defined by the Landfill Criteria, contingency measures are practical and implementable measures that may be implemented in the event of a failure or non-compliance with the Site's performance criteria.

The following list presents potential conditions and associated potential contingency measures that could be implemented at the Site.

- Increasing groundwater impacts surrounding the Landfill
  - Undertake measures to further reduce leachate generation, such as advanced placement of progressive final closure
  - Increase extent and frequency of groundwater monitoring

  - Acquire access to the affected land(s) to increase the attenuation and landfill buffer zones within the Site
- LFG impacts are detected at levels higher than 20 percent of the lower explosive limit in on-site buildings, or higher than 50 percent of the lower explosive limit at the Site boundary:
  - Install LFG migration vents and/or barriers for on-Site structures
  - Accelerate the schedule for implementation of LFG collection infrastructure.
  - Install additional LFG collection infrastructure
- Leachate derived impacts are identified in off-site surface water:
  - Review surface water management on the Landfill to prevent the release of leachate impacted water to the surface water management system and increase surface water controls
  - Accelerated the schedule of the final cover placement and construction of the post-closure surface water management works

The applicability of each contingency measures listed above to the potential Site-specific condition would be assessed at the time that the potential condition is identified.

16. References

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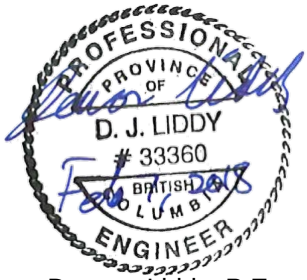
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All of Which is Respectfully Submitted,

GHD

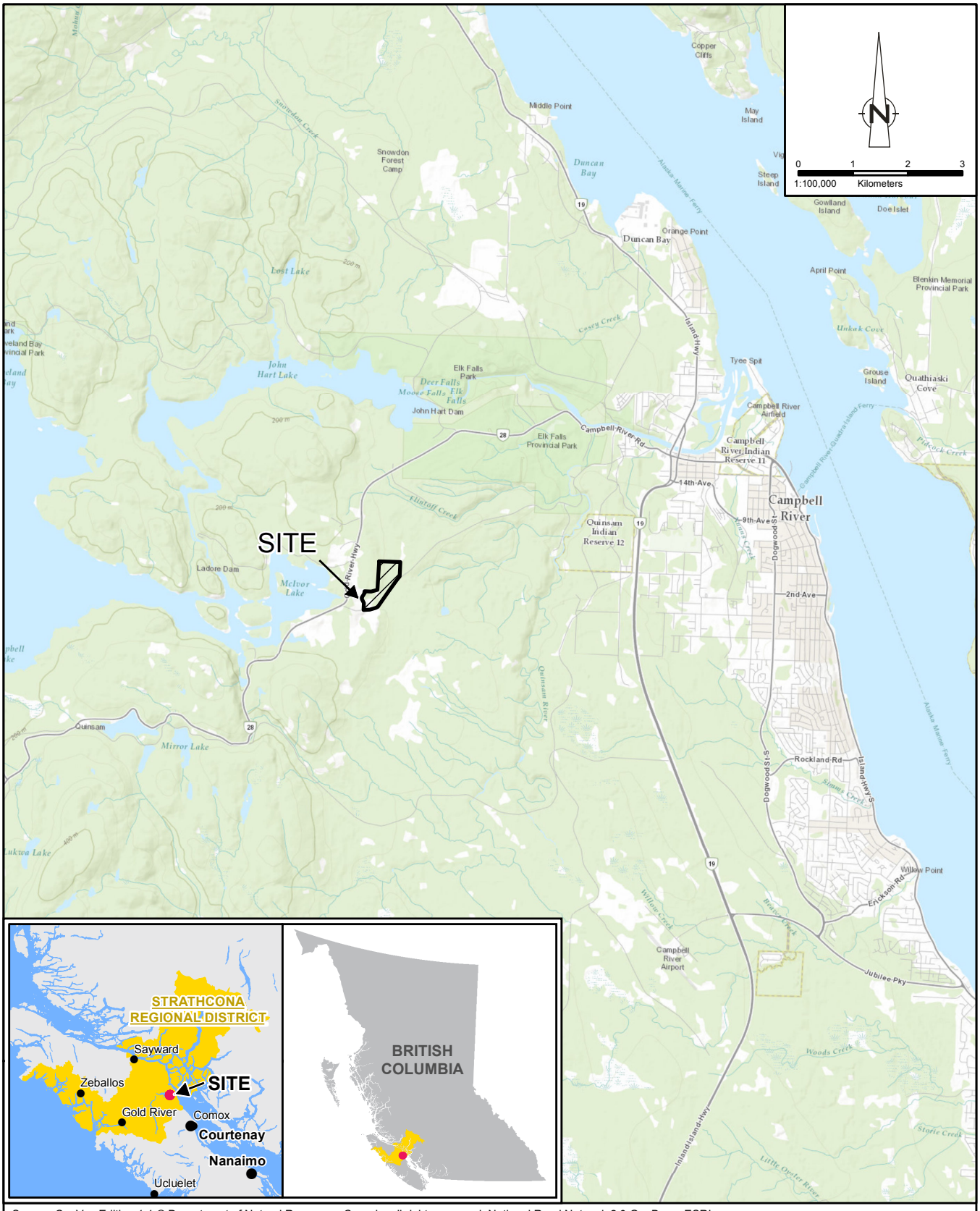
Michaela Dyck, G.I.T.



Deacon Liddy, P.Eng., MBA



Gregory D. Ferraro, P.Eng.



Source: CanVec Edition 1.1 © Department of Natural Resources Canada, all rights reserved; National Road Network 2.0 GeoBase; ESRI.
Coordinate System: NAD 1983 UTM Zone 10N

figure 1.1

SITE LOCATION
2017 DESIGN, OPERATIONS AND CLOSURE PLAN
CAMPBELL RIVER WASTE MANAGEMENT CENTRE
Comox-Strathcona Waste Management



LEGEND:

- MAJOR CONTOUR (2m INTERVAL)
- MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- CHAIN LINK FENCE
- ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- CULVERT
- M.H. MANHOLE
- EBA11-1 GROUNDWATER WELL LOCATION
- EBA04-5 DECOMMISSIONED WELL LOCATION
- EBA06-1 APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION
- SW-3 APPROXIMATE SURFACE WATER SAMPLE LOCATION

SOURCE:

EXISTING TOPOGRAPHICAL SURVEY COMPLETED OCTOBER 20, 2016 BY MCELHANNEY LAND SURVEYED LTD.

GROUNDWATER WELL LOCATION, DECOMMISSIONED WELL LOCATION, APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION, APPROXIMATE SURFACE WATER SAMPLE LOCATION FROM 2015 OPERATIONS AND MONITORING REPORT BY GHD.

APPROXIMATE LIMIT OF WASTE PER MCELHANNEY CONSULTING SERVICES LTD., DRAWING LIMIT OF EXISTING WASTE, DATED MAY 30, 2013.

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Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
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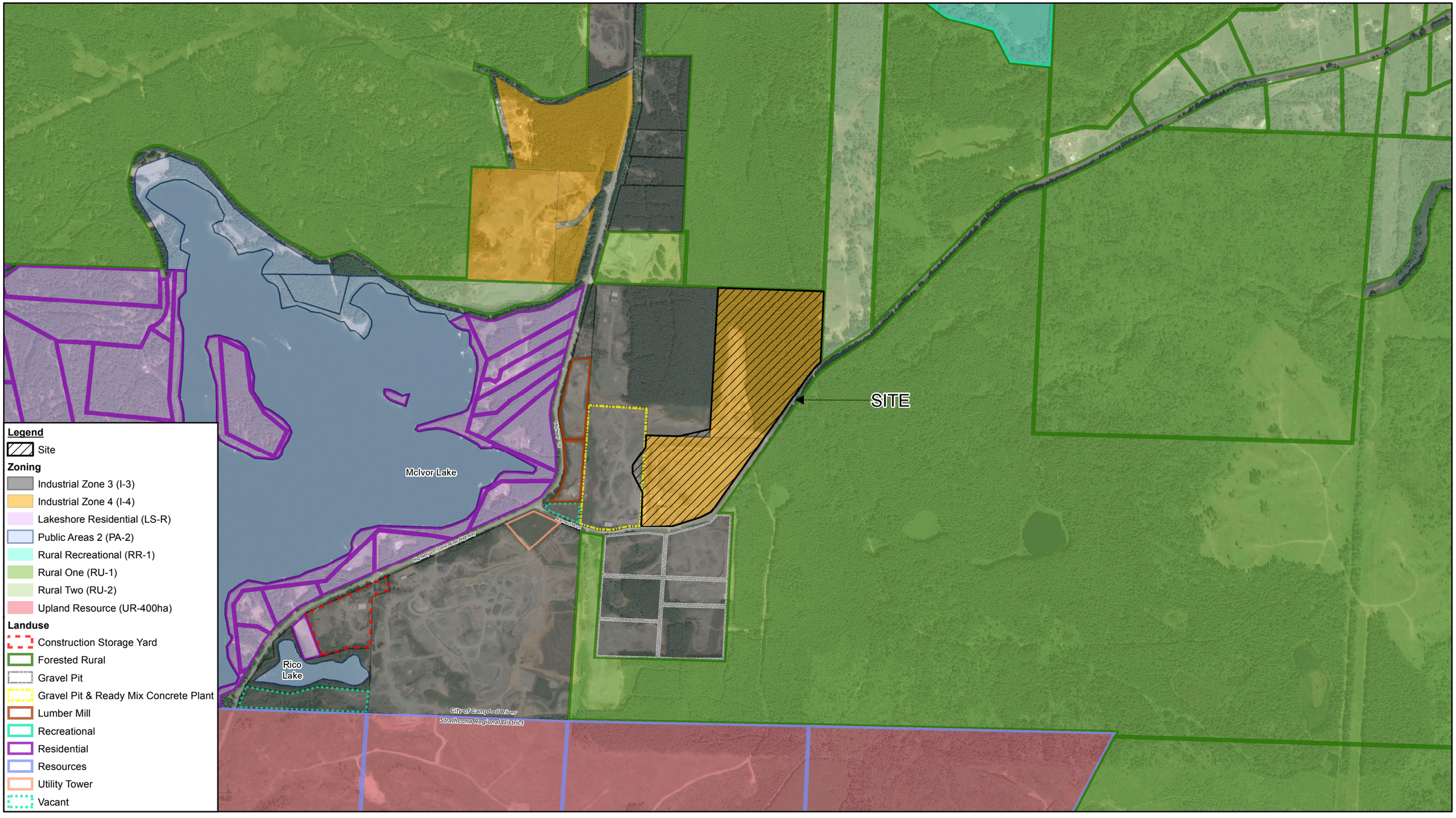
Drawn	K. RENNER	Designer	K. RENNER
Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Jul 28, 2017
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. **56484-200**

Title
SITE PLAN

Sheet No.
Figure 1.2
Sheet **2** of **2**

Plot Date: 2 November 2017 - 2:18 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)GN\56484-200(025)GN-WA003.dwg



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0 125 250 375
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

N

GHD

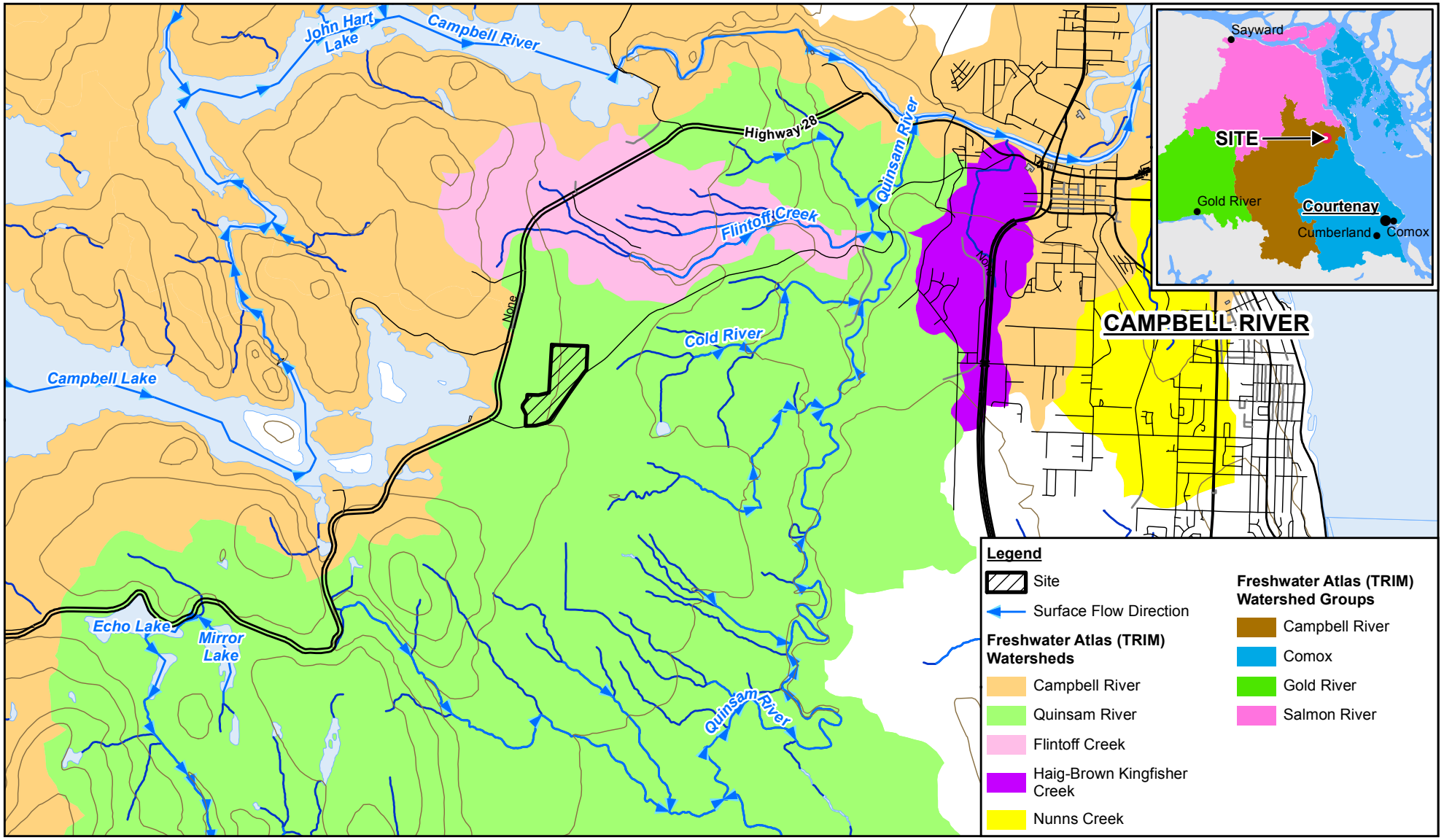
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CAMPBEL RIVER WASTE MANAGEMENT CENTRE
2017 DESIGN, OPERATIONS, AND CLOSURE PLAN

056484-200
Nov 14, 2017

SITE AREA ZONING

FIGURE 1.3

GIS File: Q:\GIS\PROJECTS\56000s\56484\Layouts\025\056484-200(025)GIS-WA001.mxd



Sources: CanVec Edition 1.1 © Department of Natural Resources Canada, all rights reserved. National Road Network 2.0 GeoBase. ESRI Base Data, 2008.
Surface Flow Direction, & Watershed Boundaries (Campbell River & Quinsam River) from BC Freshwater Atlas, 2016. Freshwater Atlas derives watershed boundaries from 1:20,000 TRIM elevations. Watershed boundary through and adjacent to property line reflects field observations & on-site aerial survey completed on 2010-11-16.

0 600 1,200 1,800
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

N

GHD

COMOX STRATHCONA WASTE MANAGEMENT
CAMPBELL RIVER WASTE MANAGEMENT CENTRE
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

REGIONAL WATERSHED MAP (FRESHWATER ATLAS - TRIM ELEVATIONS)

056484-200
Nov 2, 2017

FIGURE 2.1

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0 50 100 150m

SCALE=1:5000

BLOCK J

BLOCK K

DL. 85

BLOCK A

BLOCK C

CAMPBELL RIVER
WASTE MANAGEMENT CENTRE

ARGONAUT ROAD

McIVOR
LAKE

SW-2

EBA11-3
113.75

EBA11-4
112.49

AG99-06
113.01

AG99-05
114.48

AG99-04
116.35

AG99-03

HBT94-5
(DRY)

AG99-01
118.29

AG99-02
116.77

EBA11-2
117.91

EBA04-3
116.89

EBA11-1
114.59

ELECTRIC
FENCE

GLL93-4
(DRY)

EBA04-7
114.94

EBA04-6
114.62 (1)

EBA04-4

HBT94-4

HBT94-1
119.15

HBT94-2
119.17

HBT94-3
119.18 (1)

EBA06-1

AM02-01

MW01-16
156.97

AM00-01

GLL93-1

GLL93-2

GLL93-3

EBA04-1

109728

WEIGH SCALES
AND GATEHOUSE

PUBLIC ACCESS WASTE
DROP-OFF AREA

LEGEND

- PROPERTY BOUNDARY
- PARCEL BOUNDARY
- TOPOGRAPHIC CONTOUR
- APPROXIMATE LIMIT OF WASTE
- BEAR FENCE
- EXISTING STRUCTURE
- EBA11-1 GROUNDWATER WELL LOCATION
- EBA04-5 DECOMMISSIONED WELL LOCATION
- EBA06-1 APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION
- SW-3 APPROXIMATE SURFACE WATER SAMPLE LOCATION
- 110 GROUNDWATER ELEVATION CONTOUR
- 110.94 GROUNDWATER ELEVATION (MSL)
- GROUNDWATER FLOW DIRECTION

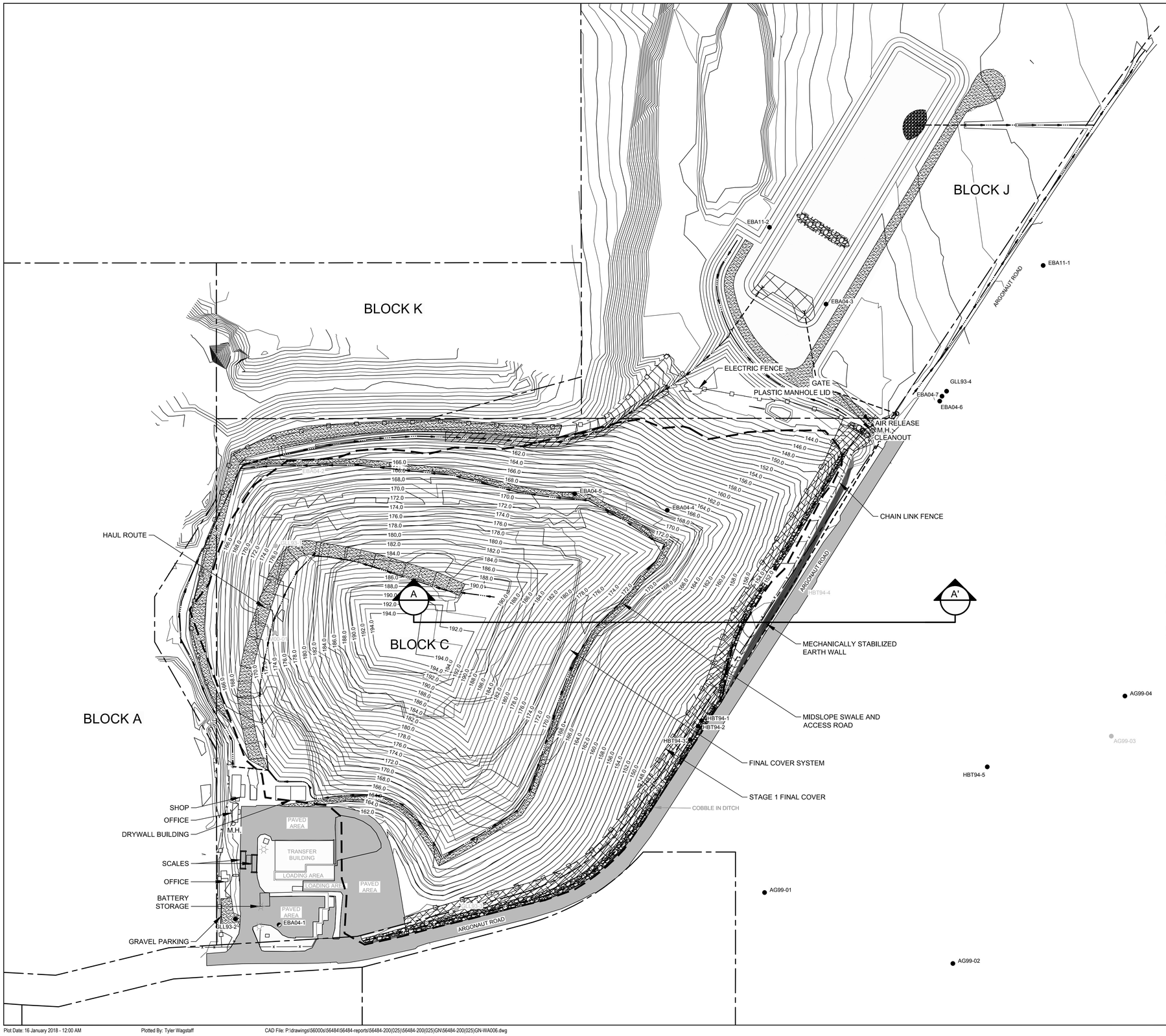
NOTES:
1. NOT USED TO GENERATE CONTOURS.

NOTE: McIVOR LAKE AND COLD CREEK TRIBUTARY LOCATIONS ARE APPROXIMATE.

SOURCE: TOPOGRAPHICAL INFORMATION BASED SURVEY BY McELHANNEY ASSOCIATES DATED OCTOBER 20, 2016
WELL LOCATIONS BASED ON SURVEY DATA PROVIDED BY TETRA TECH EBA.
APPROXIMATE LIMIT OF WASTE PER MCELHANNEY CONSULTING SERVICES LTD., DRAWING LIMIT OF EXISTING WASTE, DATED MAY 30, 2013.

figure 2.2

GROUNDWATER CONTOURS - NOVEMBER 2016
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Comox-Strathcona Waste Management



0 10 20 30 40m

LEGEND:

- FINAL CONTOUR (2m INTERVAL)
- FINAL CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- CHAIN LINK FENCE
- ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- TURF REINFORCEMENT MAT
- STAGE 1 FINAL COVER
- CULVERT
- M.H. MANHOLE
- EBA11-1 GROUNDWATER WELL LOCATION
- EBA04-5 DECOMMISSIONED WELL LOCATION
- EBA06-1 APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION
- SW-3 APPROXIMATE SURFACE WATER SAMPLE LOCATION

SOURCE:

EXISTING TOPOGRAPHICAL SURVEY COMPLETED OCTOBER 20, 2016 BY MCELHANNEY LAND SURVEYED LTD.

GROUNDWATER WELL LOCATION, DECOMMISSIONED WELL LOCATION, APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION, APPROXIMATE SURFACE WATER SAMPLE LOCATION FROM 2015 OPERATIONS AND MONITORING REPORT BY GHD.

APPROXIMATE LIMIT OF WASTE PER MCELHANNEY CONSULTING SERVICES LTD., DRAWING LIMIT OF EXISTING WASTE, DATED MAY 30, 2013.

NOTE:

CROSS-SECTION A-A' PRESENTED ON FIGURE 7.2 AND 7.3

EBA11-2 TO BE DECOMMISSIONED AS CONSTRUCTION OF THE STORMWATER MANAGEMENT POND PROGRESSES

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CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
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Drawn	K. RENNER	Designer	K. RENNER
Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Jan 15, 2018
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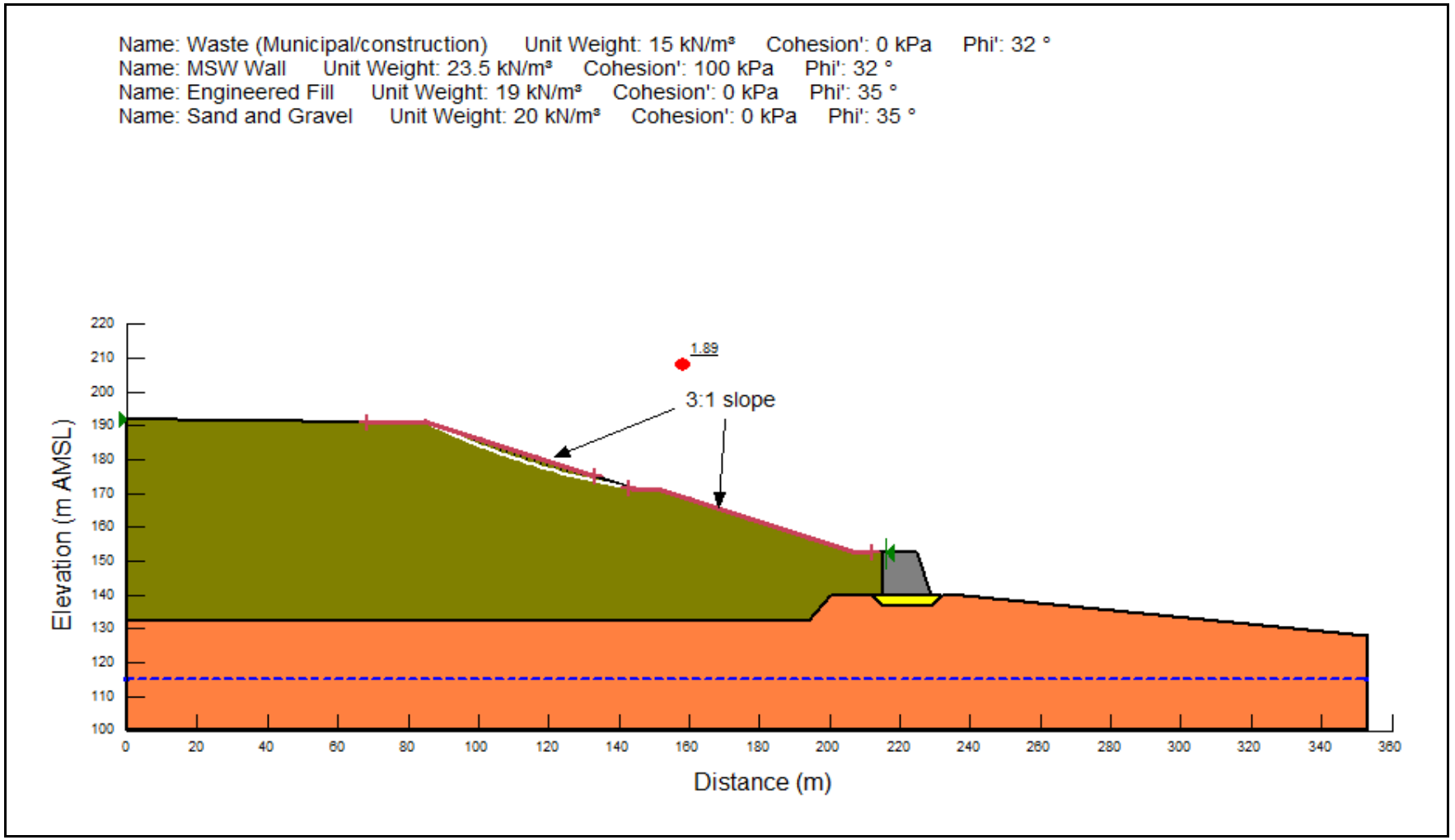
Project No. **56484-200**

Title
GLOBAL SLOPE STABILITY CROSS-SECTION

Sheet No.
FIGURE 7.1

Sheet 1 of 1

Plot Date: 16 January 2018 - 12:00 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)GN\56484-200(025)GN-WA006.dwg



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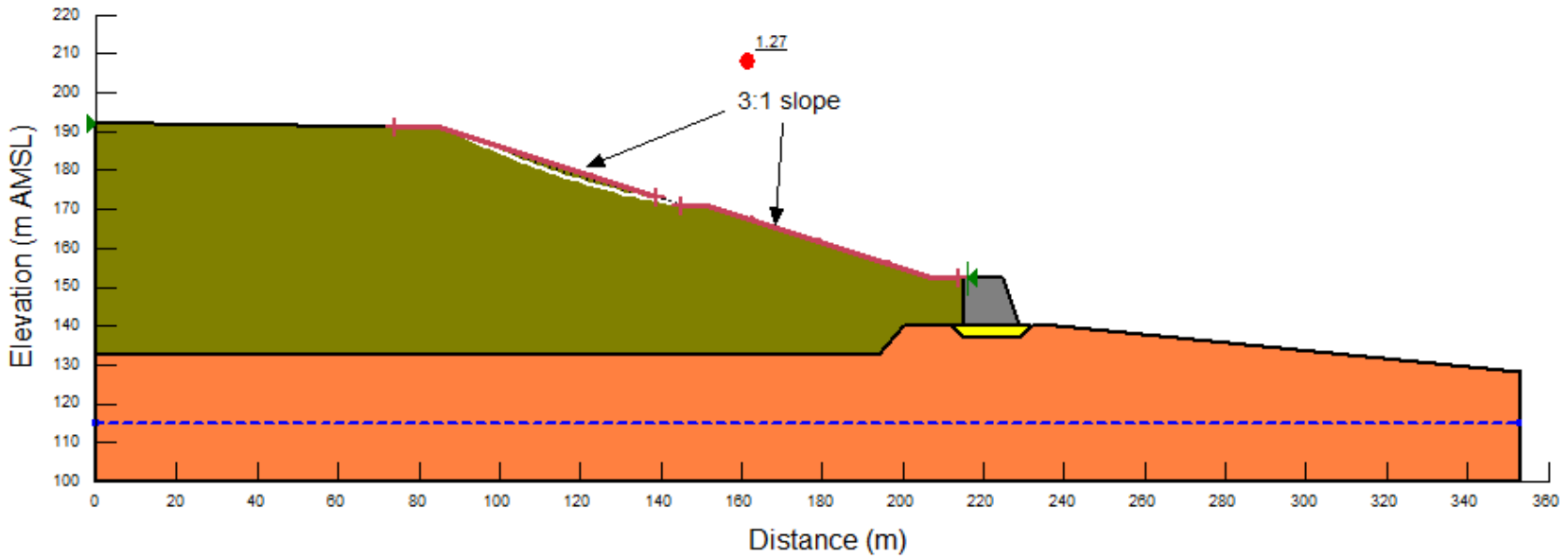
11/6/2017

Cross-section A-A' Global Stability Analysis - Static

FIGURE 7.2

Name: Waste (Municipal/construction) Unit Weight: 15 kN/m³ Cohesion': 0 kPa Phi': 32 °
Name: MSW Wall Unit Weight: 23.5 kN/m³ Cohesion': 100 kPa Phi': 32 °
Name: Engineered Fill Unit Weight: 19 kN/m³ Cohesion': 0 kPa Phi': 35 °
Name: Sand and Gravel Unit Weight: 20 kN/m³ Cohesion': 0 kPa Phi': 35 °

Seismic Coefficient (50% PGA) = 0.5x281 = 0.1405



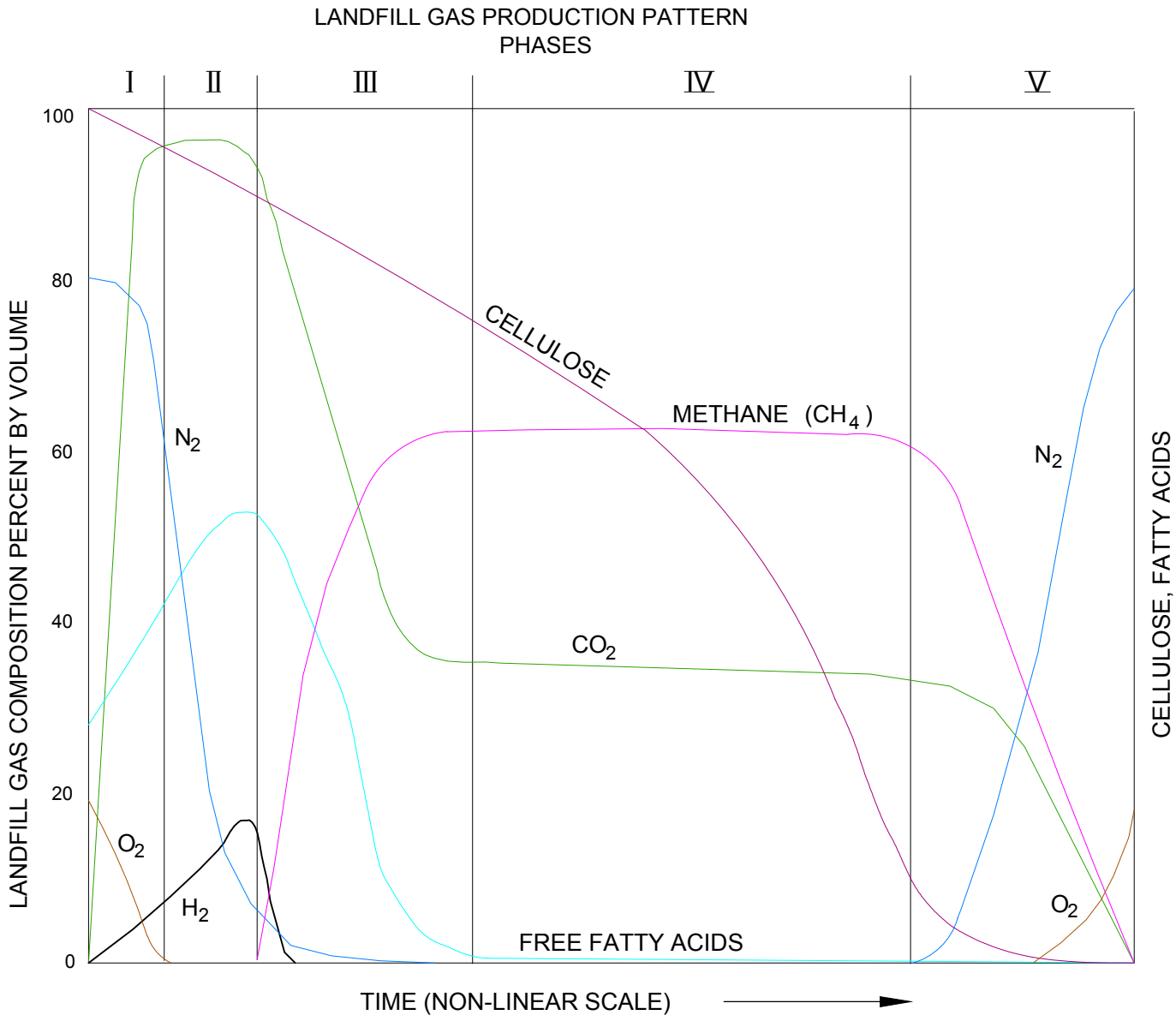
2017 Design, Operations and Closure Plan
Campbell River Waste Management Centre
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056484

11/6/2017

Cross-section A-A' Global Stability Analysis - Pseudo-Seismic

FIGURE 7.3



PHASES	CONDITION	TIME FRAME - TYPICAL
Ⅰ	AEROBIC	HOURS TO 1 WEEK
Ⅱ	ANOXIC	1 TO 6 MONTHS
Ⅲ	ANAEROBIC, METHANOGENIC, UNSTEADY	3 MONTHS TO 3 YEARS
Ⅳ	ANAEROBIC, METHANOGENIC, STEADY	8 TO 40 YEARS
Ⅴ	ANAEROBIC, METHANOGENIC, DECLINING	1 TO 40+ YEARS
TOTAL		10 TO 80+ YEARS

SOURCE:

FARQUHAR AND ROVERS, 1973,
AS MODIFIED BY REES, 1980,
AND AUGENSTEIN & PACEY, 1991.

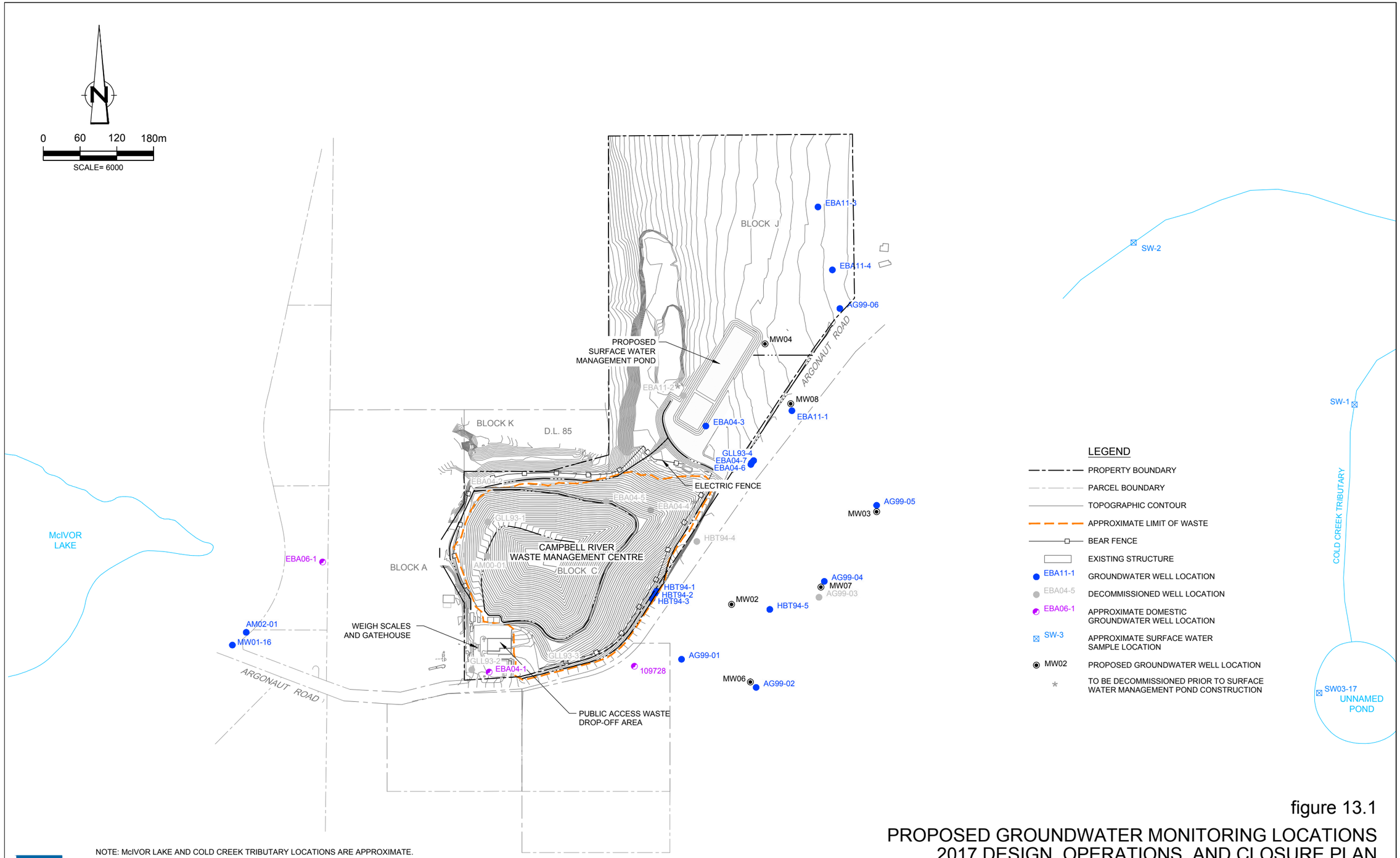
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CAMPBELL RIVER WASTE MANAGEMENT CENTRE
Comox-Strathcona Waste Management

056484-25
Jul 18, 2017

TYPICAL LANDFILL GAS PRODUCTION STAGES

FIG. 10.1

CAD File: I:\CAD\050000\056484\056484-REPORTS\056484-25(RPT)\056484-25(RPT)GN\056484-25(RPT)GN-CA001.dwg



NOTE: McIVOR LAKE AND COLD CREEK TRIBUTARY LOCATIONS ARE APPROXIMATE.

SOURCE: TOPOGRAPHICAL INFORMATION BASED SURVEY BY McELHANNEY ASSOCIATES DATED OCTOBER 20, 2016
WELL LOCATIONS BASED ON SURVEY DATA PROVIDED BY TETRA TECH EBA.
APPROXIMATE LIMIT OF WASTE PER MCELHANNEY CONSULTING SERVICES LTD., DRAWING LIMIT OF EXISTING WASTE, DATED MAY 30, 2013.
NORTH-EAST TREELINE SURVEY, RECEIVED FROM BERRY & VALE CONTRACTING LTD NOVEMEBR 30, 2017.

figure 13.1

PROPOSED GROUNDWATER MONITORING LOCATIONS 2017 DESIGN, OPERATIONS, AND CLOSURE PLAN CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Comox-Strathcona Waste Management

Table 2.1

Quinsam River Hatchery Climate Normals 1981-2010
2017 Design, Operations, and Closure Plan
Campbell River Waste Management Centre
Comox Strathcona Waste Management

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	2.8	3.7	5.8	8.5	11.9	14.9	17.3	17.4	14.1	9.2	4.9	2.6	9.4
Rainfall (mm)	219.3	150.4	141.0	101.1	72.1	62.8	41.9	49.5	59.3	180.8	249.9	234.2	1562.2
Snowfall (cm)	14.8	10.1	7.1	0.1	0	0	0	0	0	0.5	7.2	16.5	56.2

Table 5.1

Airspace Consumption by Stage
2017 Design, Operations, and Closure Plan
Campbell River Waste Management Centre
Comox Strathcona Waste Management

Stage	Area	Airspace Capacity (m^3)	Cumulative Airspace Capacity (m^3)	Amount of Waste per Stage (tonnes)	Cumulative Waste (tonnes)	Capacity (years)	Cumulative Waste (years)	Estimated Year of Completion
1	West Slope	34400	34400	20640	20640	0.83	0.83	2017.8
2	North and East Slope; South Area	17000	51400	10200	30840	0.41	1.23	2018.2
3	South Slope	16850	68250	10110	40950	0.57	1.80	2018.8
4	Upper Plateau 177-181 m	39850	108100	23910	64860	1.35	3.16	2020.2
5	Upper Plateau 181-184 m	39500	147600	23700	88560	1.34	4.49	2021.5
6	Upper Plateau 184-187 m	26650	174250	15990	104550	0.90	5.40	2022.4
7	Upper Plateau 187-194 m	23450	197700	14070	118620	0.79	6.19	2023.2

Notes:

*Based on a fill rate of 25,000 tonnes per year for Phase 1 to 2 and 17,700 tonnes per year for Phase 3 to 7; an airspace consumption rate of 0.6 tonnes per cubic metre.

Material Requirements
2017 Design, Operations, and Closure Plan
Campbell River Waste Management Centre
Comox Strathcona Waste Management

	Operations		Final Cover			
	Volume		Area		Volume	
Phase	Daily Cover Volume (m^3)[1]	Intermediate Cover Volume (m^3)	Final Cover GCL Area (m^2)	60 mil LLDPE (m^2)	Final Cover Sand (m^3)	Final Cover Topsoil (m^3)
0	0	0	0	0	0	0
1	2,867	2,700	0	0	0	0
2	1,417	7,825	0	0	0	0
3	1,404	1,825	0	0	0	0
4	3,321	2,380	0	0	0	0
5	3,292	1,534	0	0	0	0
6	2,221	1,284	0	0	0	0
7	1,954	2,486	93,880	93,880	56,328	14,082
Total	**16,475**	**20,034**	**93,880**	**93,880**	**56,328**	**14,082**

Total Fill (Sand) (m^3)	92,837
Total Cut (m^3)	65,400

Notes:
(1) Waste to Daily Cover Ratio of 12:1

Table 7.1

Infinite Slope Analysis
2017 Design, Operations, and Closure Plan
Campbell River Waste Management Centre
Comox Strathcona Waste Management

Critical Interface	Cover Density g (kN/m^3)	Layer Thickness (m)	Depth to Failure plane z (m)	Depth to Water d_w (m)	Interface Shear Strength		Landfill Slope b		Factor of Safety		K_y
					Cohesion c (kPa)	Angle of friction (f)	H:V	Degrees	Static	Pseudo-static	
Top soil + sand protective cover Vs Non-woven needle punched Geotextile (upper face of geomposite)	20	0.75	0.79	0.70	0	28	3 :1	18.4	1.51	1.01	0.14
Top soil + sand protective cover + Non-woven needle punched Geotextile (lower face of geomposite) Vs Textured 60 mil LLDPE	20	0.75	0.79	0.70	0	32	3 :1	18.4	1.77	1.18	0.21
Top soil + sand protective cover + Geomposite) + Textured 60 mil LLDPE Vs Intermediate Cover	20	0.75	0.79	0.70	5	30	3 :1	18.4	2.69	1.83	0.47

Factor of Safety (FS) = $\dfrac{c/(g.z.\cos^2 b) + \tan f\,[1-g_w(z-d_w)/(g.z)] - k_s \tan b \tan f}{k_s + \tan b}$

yield acceleration k_y = $\dfrac{c/(g.z.\cos^2 b) + \tan f\,[1-g_w(z-d_w)/(g.z)] - \tan b}{1 + \tan f \tan b}$

g_w (density of water kN/m^3) = 9.81

Seismic coefficient k_s = 0.141 g

For Static Factor of Safety k_s = 0

Notes:
1) Depth to critical surface/water measured vertically from the ground surface
2) Yield acceleration k_y = 50 percent of the amplified maximum horizontal acceleration of 0.281g.
3) The calculated factors of safety are based on assumed interface friction values from CRA database values and must be confirmed by site-specific testing.

CAMPBELL RIVER WASTE MANAGEMENT CENTRE
CAMPBELL RIVER, BRITISH COLUMBIA
2017 DESIGN, OPERATIONS, AND CLOSURE PLAN

56484-200

SOURCE:
JANUARY 01, 2007. GOVERNMENT OF CANADA, NATURAL RESOURCES CANADA.



AREA MAP

SOURCE:
BING IMAGERY: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION



SITE MAP

DRAWING INDEX

DWG NO.	REV NO.	DATE	TITLE
C-01	1	NOVEMBER 2017	EXISTING CONDITIONS
C-02	1	NOVEMBER 2017	FINAL CONTOURS
C-03	1	NOVEMBER 2017	SURFACE WATER WORKS #1
C-04	1	NOVEMBER 2017	SURFACE WATER WORKS #2
C-05	1	NOVEMBER 2017	SURFACE WATER WORKS #3
C-06	1	NOVEMBER 2017	CROSS SECTIONS
C-07	1	NOVEMBER 2017	FILL PLAN - STAGE 1
C-08	1	NOVEMBER 2017	FILL PLAN - STAGE 2
C-09	1	NOVEMBER 2017	FILL PLAN - STAGE 3
C-10	1	NOVEMBER 2017	FILL PLAN - STAGE 4
C-11	1	NOVEMBER 2017	FILL PLAN - STAGE 5
C-12	1	NOVEMBER 2017	FILL PLAN - STAGE 6
C-13	1	NOVEMBER 2017	FILL PLAN - STAGE 7
C-14	1	NOVEMBER 2017	DETAIL SHEET 1
C-15	1	NOVEMBER 2017	DETAIL SHEET 2
C-16	1	NOVEMBER 2017	DETAIL SHEET 3
C-17	0	NOVEMBER 2017	DETAIL SHEET 4

Plot Date: 8 February 2018 - 3:18 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)GN\56484-200(025)GN-WA001.dwg



0 20 40 60m

LEGEND:

- MAJOR CONTOUR (5m INTERVAL)
- MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- SITE BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- CHAIN LINK FENCE
- ELECTRIC FENCE
- LIMIT OF EXISTING FINAL COVER
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- CULVERT
- M.H. MANHOLE
- EBA11-1 GROUNDWATER WELL LOCATION
- EBA04-5 DECOMMISSIONED WELL LOCATION
- EBA06-1 APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION
- SW-3 APPROXIMATE SURFACE WATER SAMPLE LOCATION

SOURCE:

EXISTING TOPOGRAPHICAL SURVEY COMPLETED OCTOBER 20, 2016 BY MCELHANNEY LAND SURVEYED LTD.

GROUNDWATER WELL LOCATION, DECOMMISSIONED WELL LOCATION, APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION, APPROXIMATE SURFACE WATER SAMPLE LOCATION FROM 2015 OPERATIONS AND MONITORING REPORT BY GHD.

APPROXIMATE LIMIT OF WASTE PER MCELHANNEY CONSULTING SERVICES LTD., DRAWING LIMIT OF EXISTING WASTE, DATED MAY 30, 2013.

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2017 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR MOE REVIEW	TW	GF	02/07/2018

Drawn	K. RENNER	Designer	K. RENNER
Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
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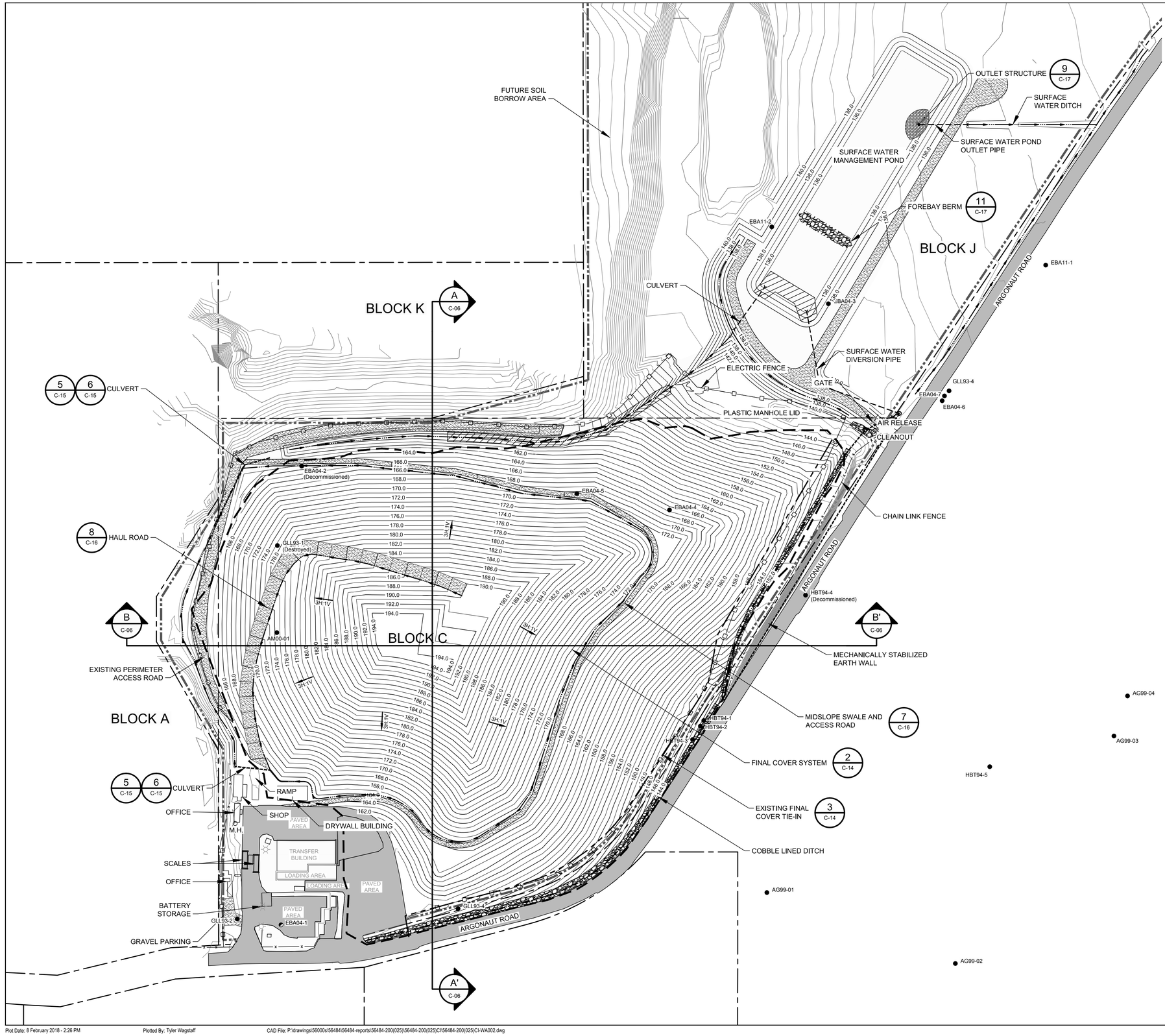
Project No. **56484-200**

Title
EXISTING CONDITIONS OCTOBER 20, 2016

Sheet No.
C-01

Sheet **2** of **17**

Plot Date: 8 February 2018 - 3:19 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)CI\56484-200(025)CI-WA001.dwg



LEGEND:

- 180.0 — FINAL CONTOUR (2m INTERVAL)
- FINAL CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- SITE BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- x — x — CHAIN LINK FENCE
- ELECTRIC FENCE
- LIMIT OF EXISTING FINAL COVER
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- TURF REINFORCEMENT MAT
- CULVERT / SURFACE WATER PIPE
- M.H. MANHOLE
- EBA11-1 GROUNDWATER WELL LOCATION
- EBA04-5 DECOMMISSIONED WELL LOCATION
- EBA06-1 APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION
- SW-3 APPROXIMATE SURFACE WATER SAMPLE LOCATION

SOURCE:

EXISTING TOPOGRAPHICAL SURVEY COMPLETED OCTOBER 20, 2016 BY MCELHANNEY LAND SURVEYED LTD.

GROUNDWATER WELL LOCATION, DECOMMISSIONED WELL LOCATION, APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION, APPROXIMATE SURFACE WATER SAMPLE LOCATION FROM 2015 OPERATIONS AND MONITORING REPORT BY GHD.

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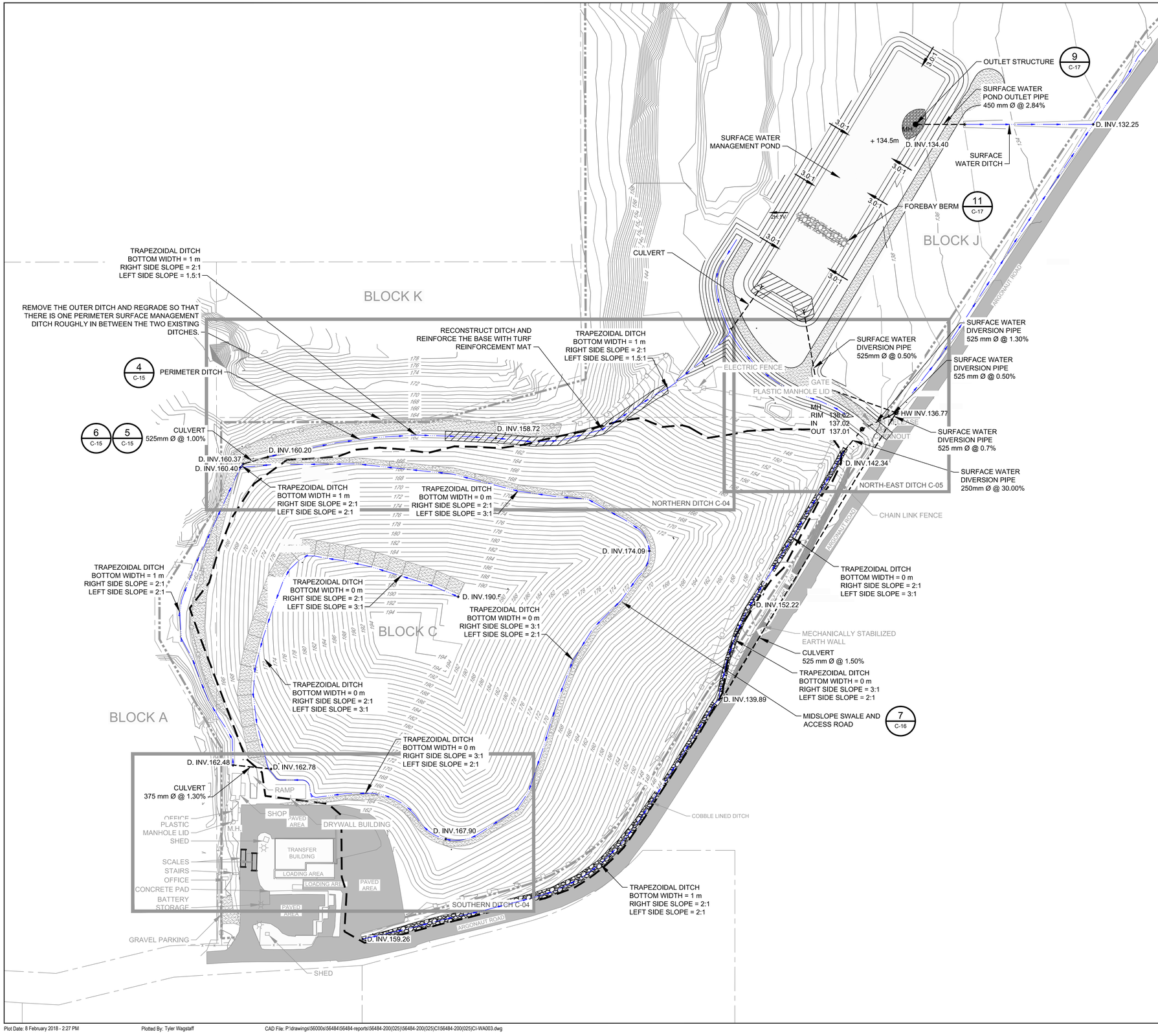
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. **56484-200**

Title
FINAL CONTOURS

Sheet No.
C-02

Sheet 3 of 17



N

0 10 20 30 40m

LEGEND:

- 180.0 — STORMWATER MANAGEMENT POND (2m INTERVAL)
- STORMWATER MANAGEMENT POND (1m INTERVAL)
- 180.0 — EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- SITE BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- CHAIN LINK FENCE
- ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- TURF REINFORCEMENT MAT
- CULVERT
- M.H. MANHOLE

SOURCE:

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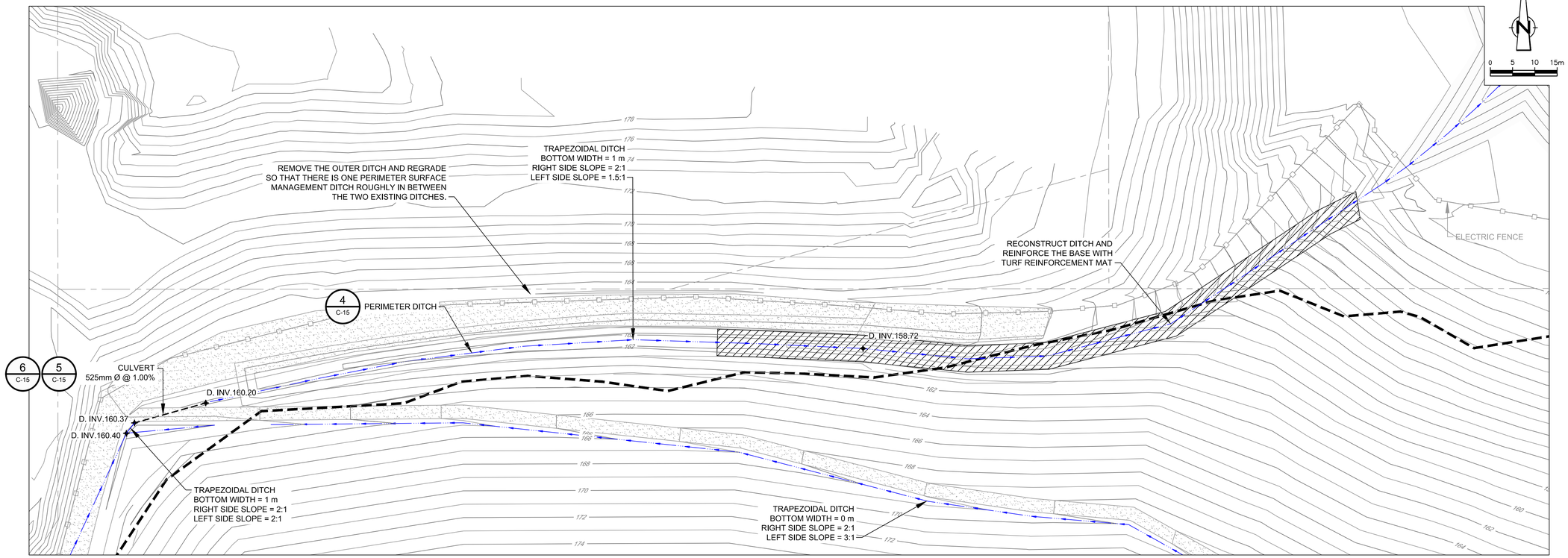
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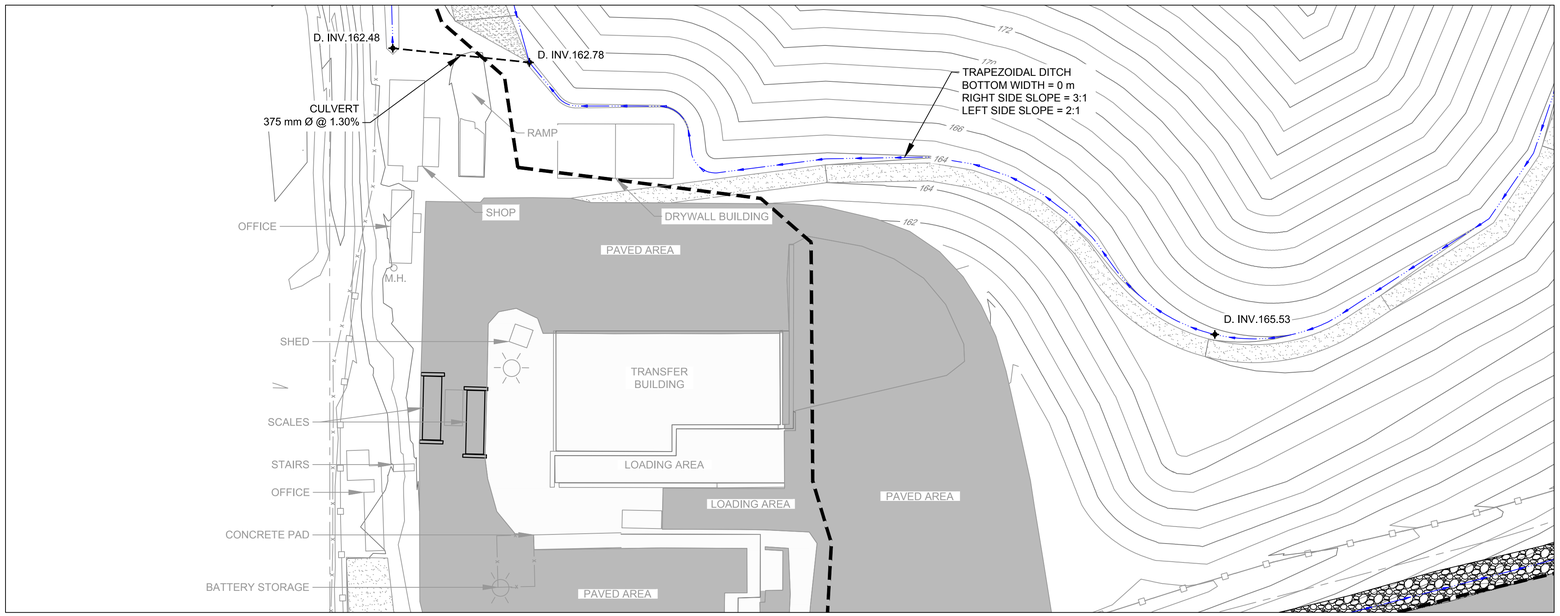
Title
SURFACE WATER WORKS #1

Sheet No.
C-03

Sheet 4 of 17



NORTHERN DITCH
SCALE: 1:500



SOUTHERN DITCH
SCALE: 1:500

LEGEND:

- 180.0 — STORMWATER MANAGEMENT POND (2m INTERVAL)
- STORMWATER MANAGEMENT POND (1m INTERVAL)
- 180.0 — EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- CHAIN LINK FENCE
- ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- TURF REINFORCEMENT MAT
- CULVERT
- M.H. MANHOLE

SOURCE:

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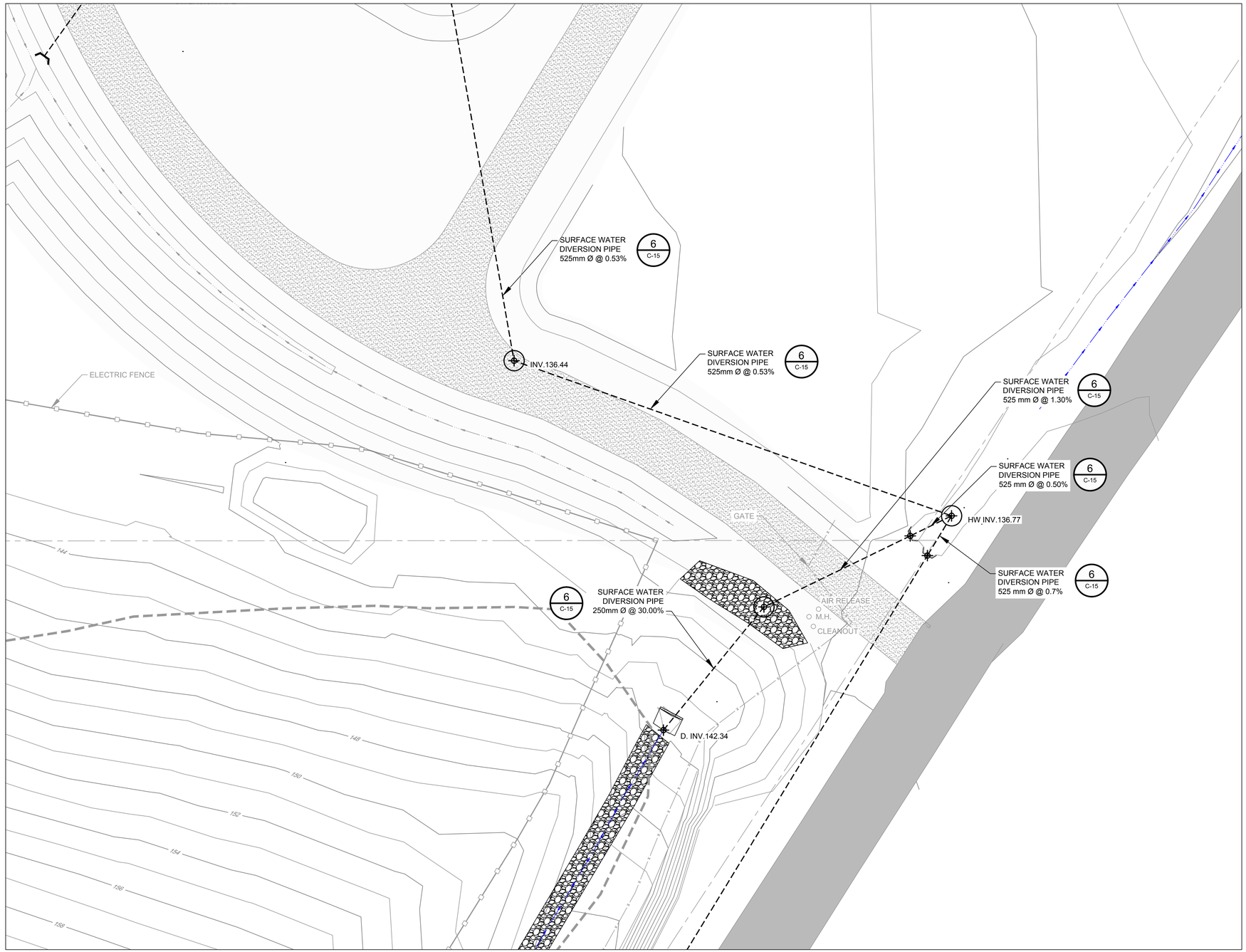
Project No. **56484-200**

Title
SURFACE WATER WORKS #2

Sheet No.
C-04

Sheet 5 of 17

Plot Date: 8 February 2018 - 2:31 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)CI\56484-200(025)CI-WA004.dwg



NORTH-EAST DITCH
SCALE: 1:500

0 2 4 6 8m

LEGEND:

- STORMWATER MANAGEMENT POND (2m INTERVAL)
- STORMWATER MANAGEMENT POND (1m INTERVAL)
- EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- DRAINAGE DITCH
- CHAIN LINK FENCE
- ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- TURF REINFORCEMENT MAT
- CULVERT
- MANHOLE

SOURCE:

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2017 DESIGN, OPERATIONS AND CLOSURE PLAN

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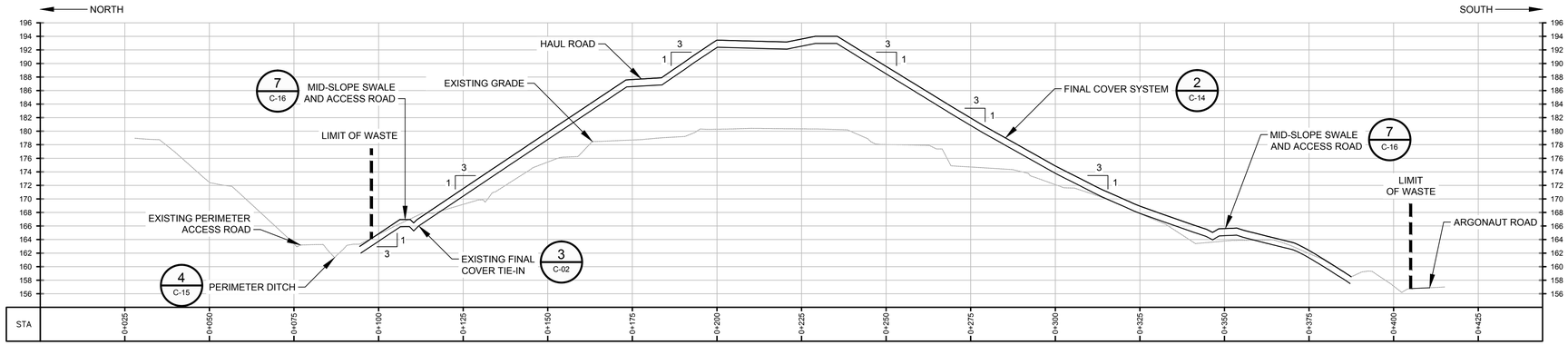
Project No. **56484-200**

Title
SURFACE WATER WORKS #3

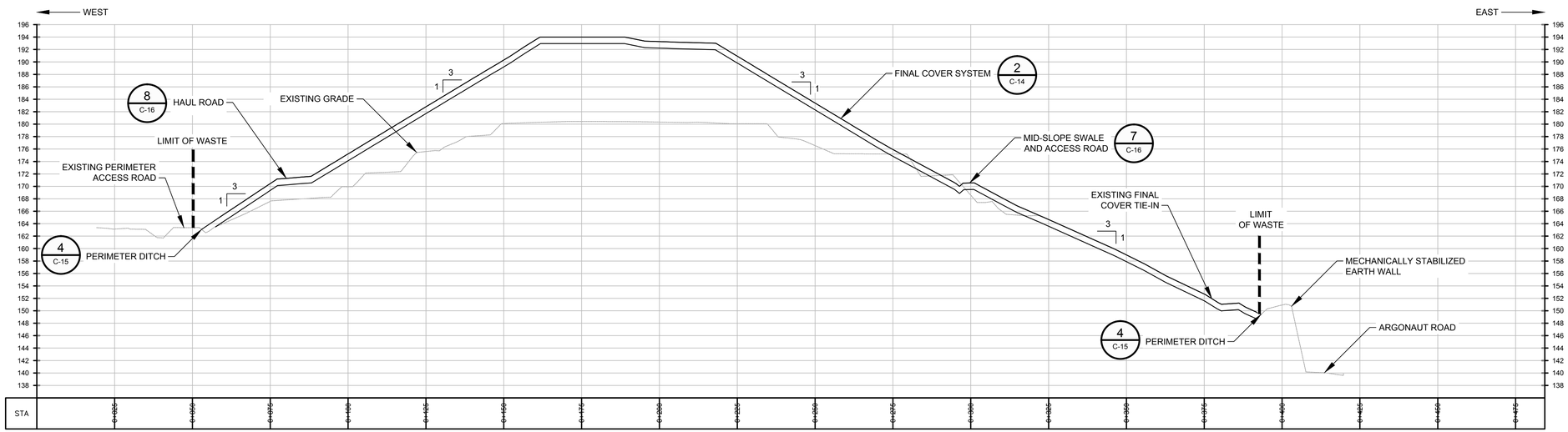
Sheet No.
C-05

Sheet 6 of 17

Plot Date: 8 February 2018 - 2:37 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)C\56484-200(025)CI-WA005.dwg



SECTION A-A' (C-02)
HORZ. 1:800
VERT. 1:400



SECTION B-B' (C-02)
HORZ. 1:800
VERT. 1:400

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Project
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

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Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 — 20mm

Project No. **56484-200**

Title
CROSS-SECTIONS

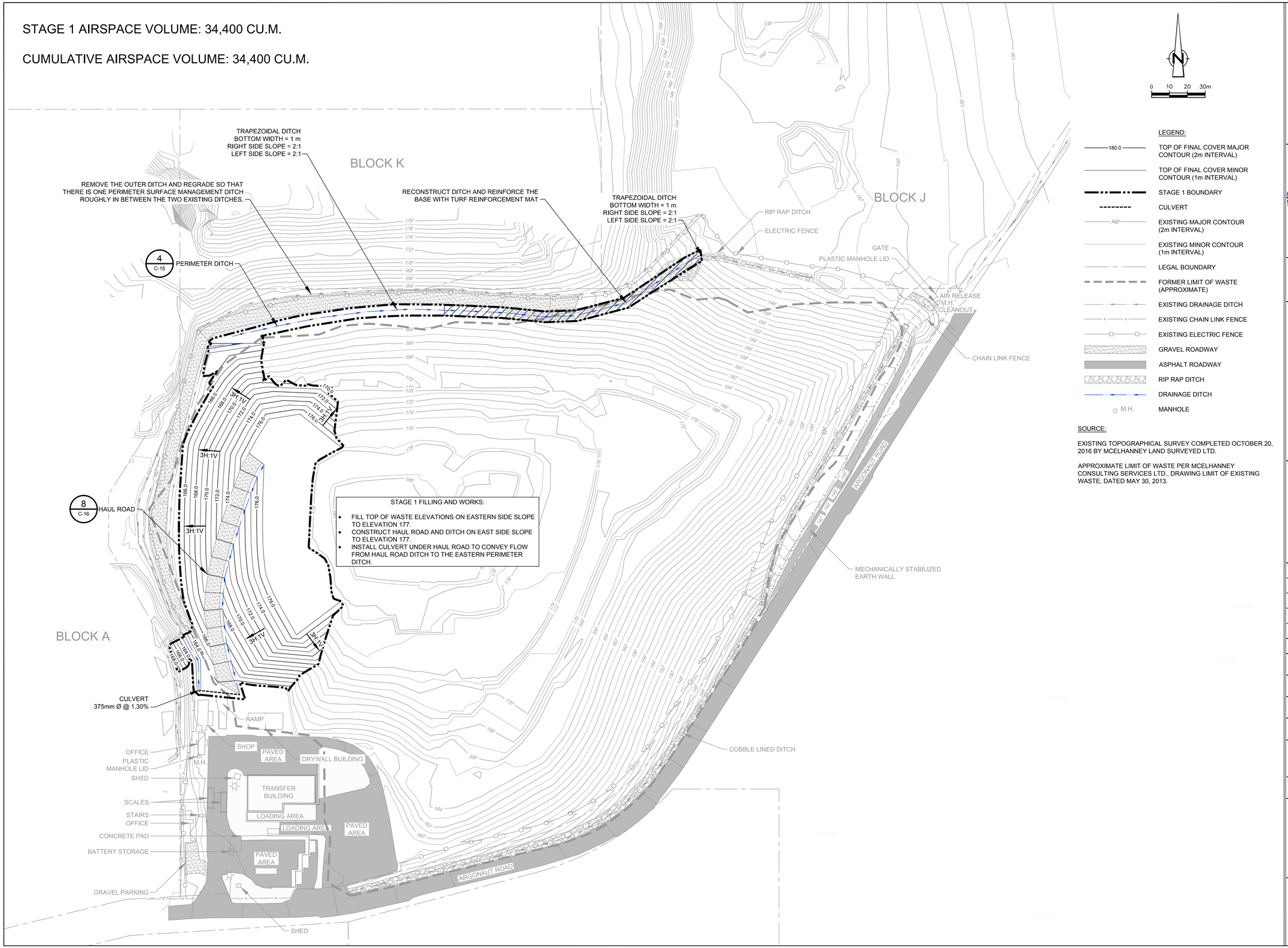
Sheet No.
C-06

Sheet 7 of 17

Plot Date: 8 February 2018 - 2:38 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)CI\56484-200(025)CI-WA006.dwg

STAGE 1 AIRSPACE VOLUME: 34,400 CU.M.

CUMULATIVE AIRSPACE VOLUME: 34,400 CU.M.



LEGEND:

- TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- STAGE 1 BOUNDARY
- CULVERT
- EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- DRAINAGE DITCH
- M.H. MANHOLE

SOURCE:

EXISTING TOPOGRAPHICAL SURVEY COMPLETED OCTOBER 20, 2016 BY MCELHANNEY LAND SURVEYED LTD.

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CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR MOE REVIEW	TW	GF	02/07/2018

Drawn	K. RENNER	Designer	K. RENNER
Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
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Project No. 56484-200

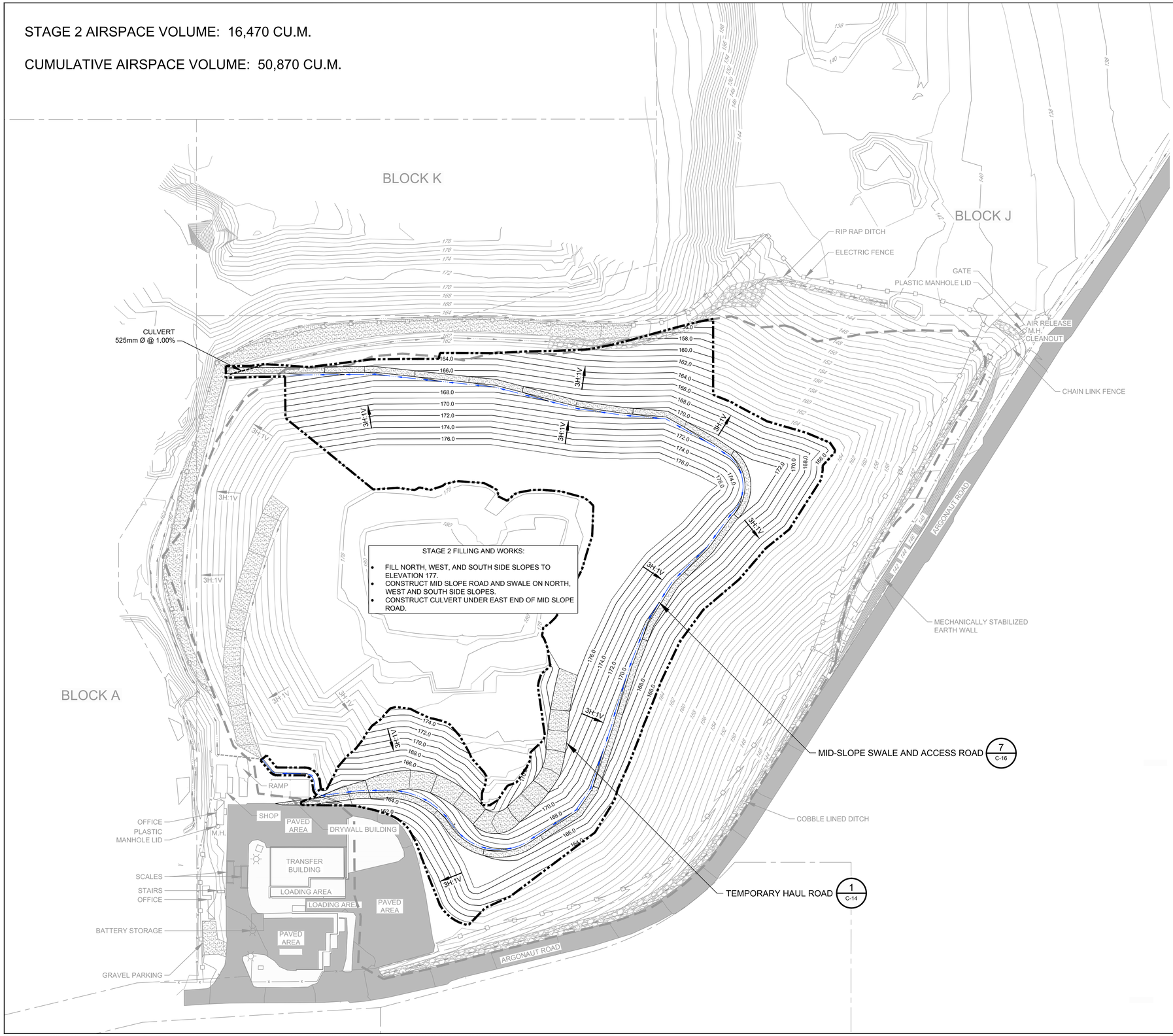
Title
FILL PLAN STAGE 1

Sheet No.
C-07

Sheet 8 of 17

STAGE 2 AIRSPACE VOLUME: 16,470 CU.M.

CUMULATIVE AIRSPACE VOLUME: 50,870 CU.M.



LEGEND:

- 180.0 — TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- STAGE 2 BOUNDARY
- 140 — EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- DRAINAGE DITCH
- CULVERT
- M.H. MANHOLE

SOURCE:

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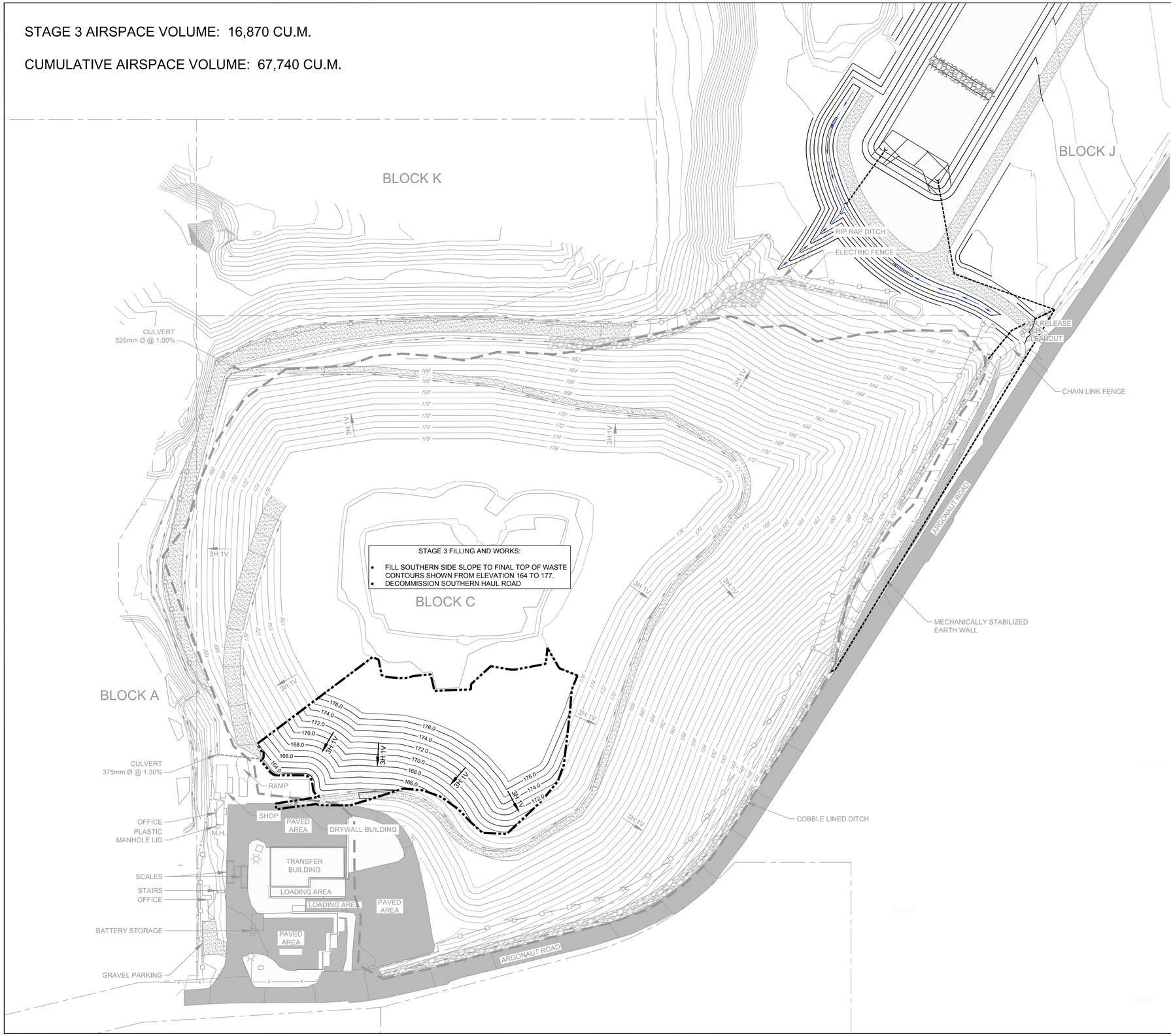
Title
FILL PLAN STAGE 2

Sheet No.
C-08

Sheet 9 of 17

STAGE 3 AIRSPACE VOLUME: 16,870 CU.M.

CUMULATIVE AIRSPACE VOLUME: 67,740 CU.M.



LEGEND:

- 180.0 — TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- 180 — SURFACE WATER MANAGEMENT POND MAJOR CONTOUR (2m INTERVAL)
- SURFACE WATER MANAGEMENT POND MINOR CONTOUR (2m INTERVAL)
- STAGE 4 BOUNDARY
- 140 — EXISTING MAJOR CONTOUR (2mt INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- CULVERT
- DRAINAGE DITCH
- M.H. MANHOLE

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Project No. **56484-200**

Title
FILL PLAN STAGE 3

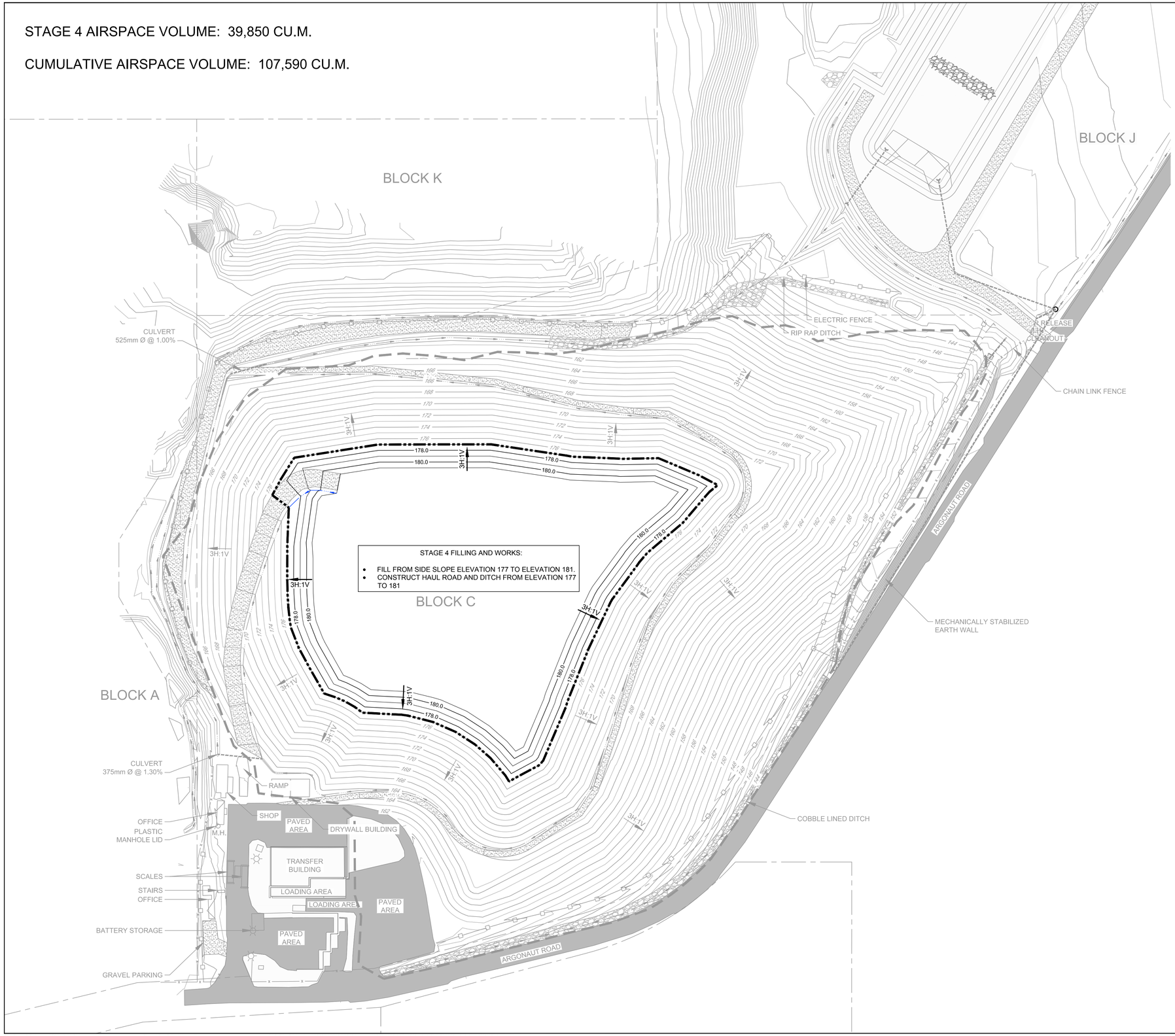
Sheet No.
C-09

Sheet 10 of 17

Plot Date: 8 February 2018 - 2:49 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)CI\56484-200(025)CI-WA009.dwg

STAGE 4 AIRSPACE VOLUME: 39,850 CU.M.

CUMULATIVE AIRSPACE VOLUME: 107,590 CU.M.



STAGE 4 FILLING AND WORKS:

- FILL FROM SIDE SLOPE ELEVATION 177 TO ELEVATION 181.
- CONSTRUCT HAUL ROAD AND DITCH FROM ELEVATION 177 TO 181

0 10 20 30m

LEGEND:

- 180.0 — TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- STAGE 5 BOUNDARY
- 140 — EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- CULVERT
- DRAINAGE DITCH
- M.H. MANHOLE

SOURCE:

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Project No. **56484-200**

Title
FILL PLAN STAGE 4

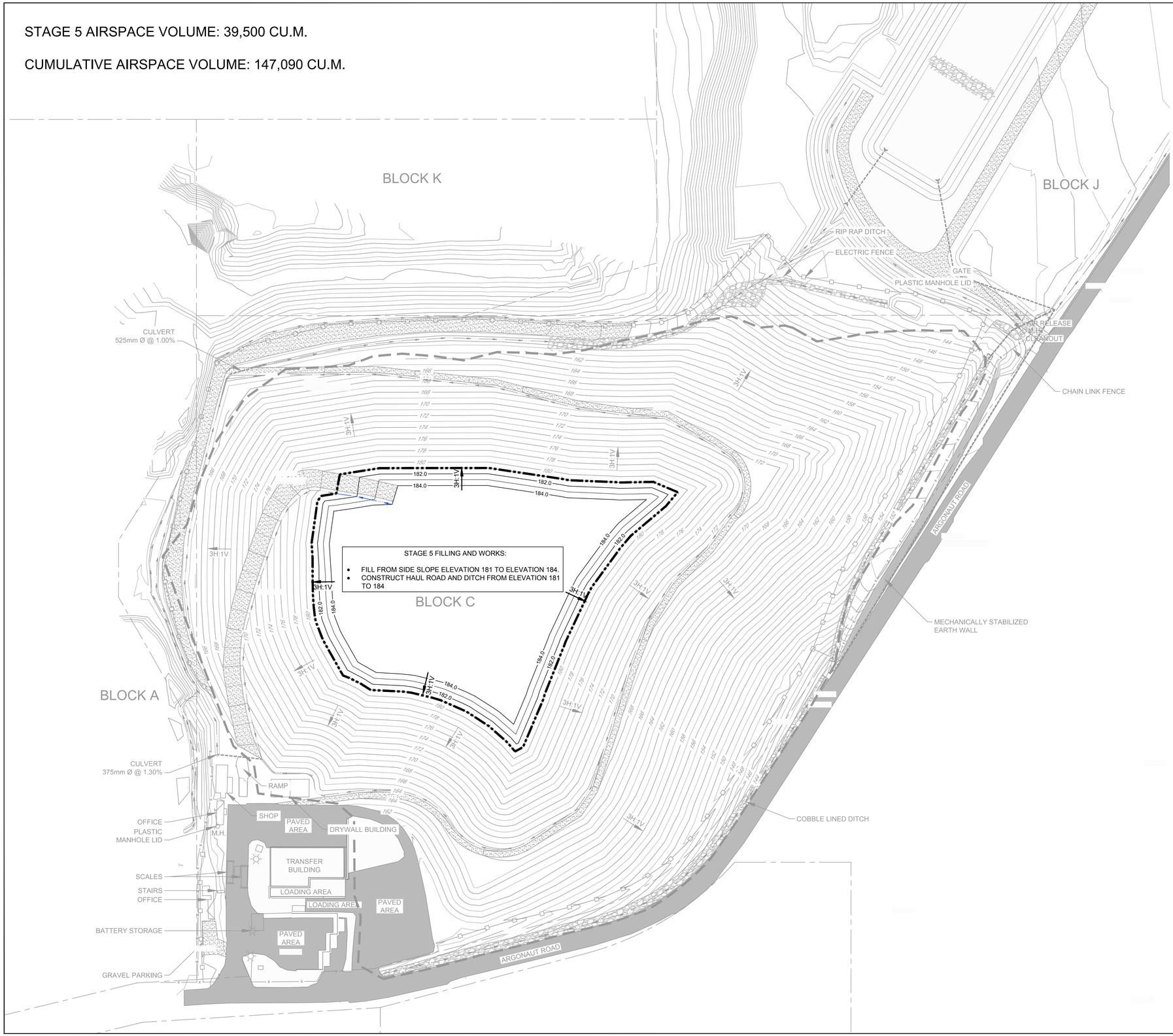
Sheet No.
C-10

Sheet 11 of 17

Plot Date: 8 February 2018 - 2:51 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)CI\56484-200(025)CI-WA010.dwg

STAGE 5 AIRSPACE VOLUME: 39,500 CU.M.

CUMULATIVE AIRSPACE VOLUME: 147,090 CU.M.



0 10 20 30m

LEGEND:

- TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- STAGE 5 BOUNDARY
- EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- CULVERT
- DRAINAGE DITCH
- M.H. MANHOLE

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Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
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Project No. **56484-200**

Title
FILL PLAN STAGE 5

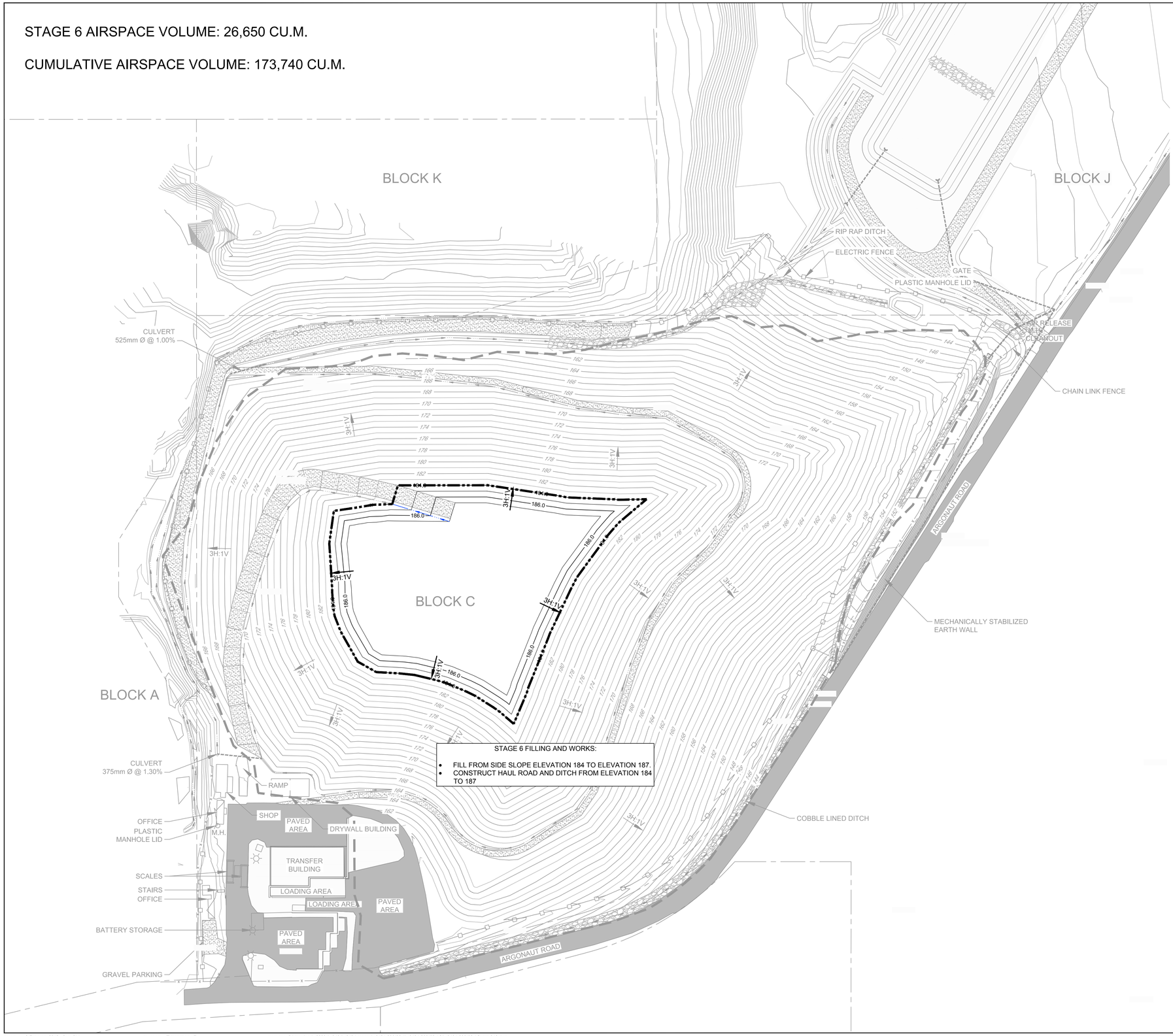
Sheet No.
C-11

Sheet **12** of **17**

Plot Date: 8 February 2018 - 2:52 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)C\56484-200(025)CI-WA011.dwg

STAGE 6 AIRSPACE VOLUME: 26,650 CU.M.

CUMULATIVE AIRSPACE VOLUME: 173,740 CU.M.



0 10 20 30m

LEGEND:

- 180.0 — TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- STAGE 6 BOUNDARY
- 140 — EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
- GRAVEL ROADWAY
- ASPHALT ROADWAY
- RIP RAP DITCH
- CULVERT
- DRAINAGE DITCH
- M.H. MANHOLE

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Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
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Project No. **56484-200**

Title
FILL PLAN STAGE 6

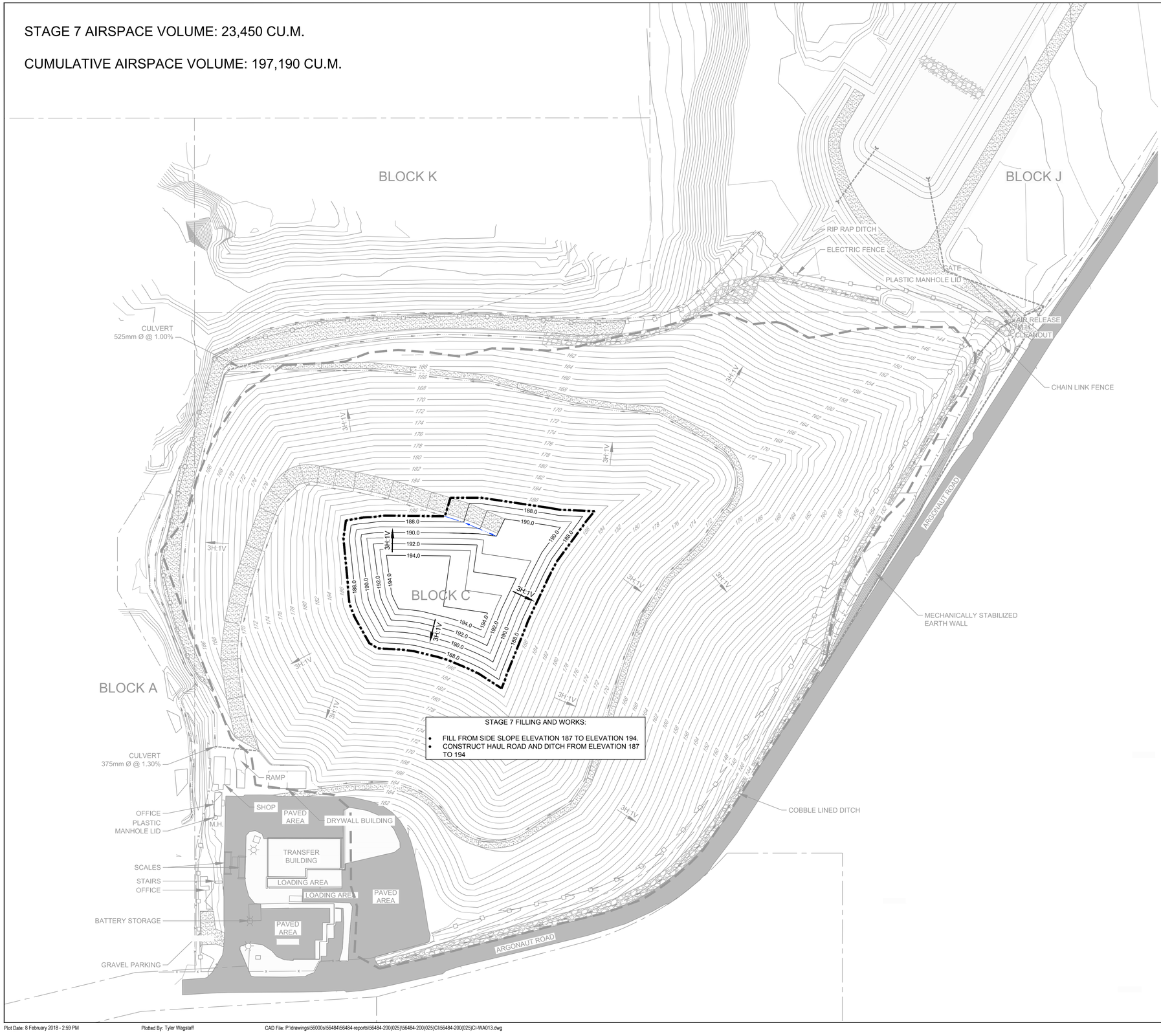
Sheet No.
C-12

Sheet 13 of 17

Plot Date: 8 February 2018 - 2:57 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(025)\56484-200(025)CI\56484-200(025)CI-WA012.dwg

STAGE 7 AIRSPACE VOLUME: 23,450 CU.M.

CUMULATIVE AIRSPACE VOLUME: 197,190 CU.M.



0 10 20 30m

LEGEND:

- TOP OF FINAL COVER MAJOR CONTOUR (2m INTERVAL)
- TOP OF FINAL COVER MINOR CONTOUR (1m INTERVAL)
- STAGE 7 BOUNDARY
- EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- LEGAL BOUNDARY
- FORMER LIMIT OF WASTE (APPROXIMATE)
- EXISTING DRAINAGE DITCH
- EXISTING CHAIN LINK FENCE
- EXISTING ELECTRIC FENCE
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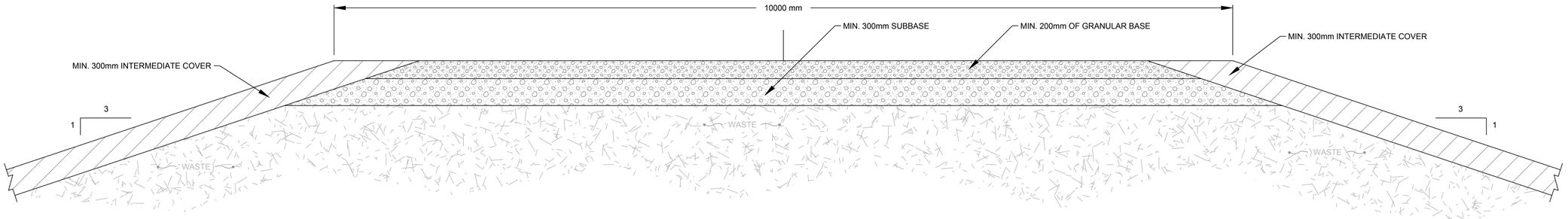
Project No. **56484-200**

Title
FILL PLAN STAGE 7

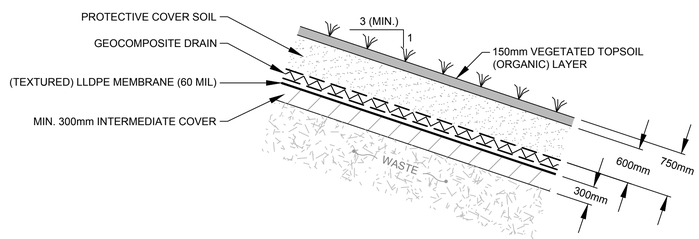
Sheet No.
C-13

Sheet **14** of **17**

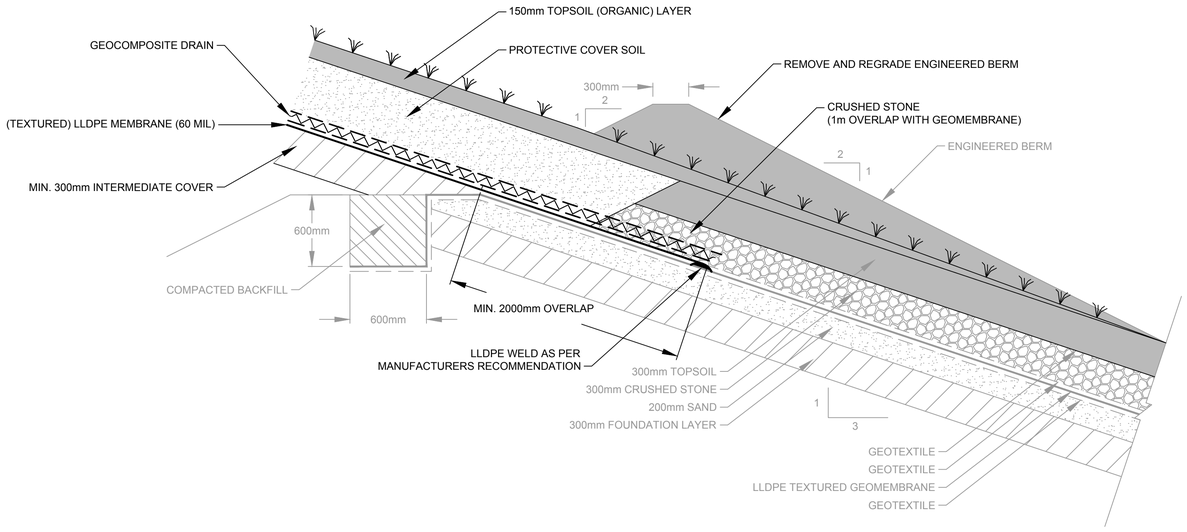
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DETAIL 1 TEMPORARY HAUL ROAD
1:25 C-02



DETAIL 2 FINAL COVER SYSTEM
1:50 C-02



DETAIL 3 EXISTING FINAL COVER TIE-IN
1:25 C-02

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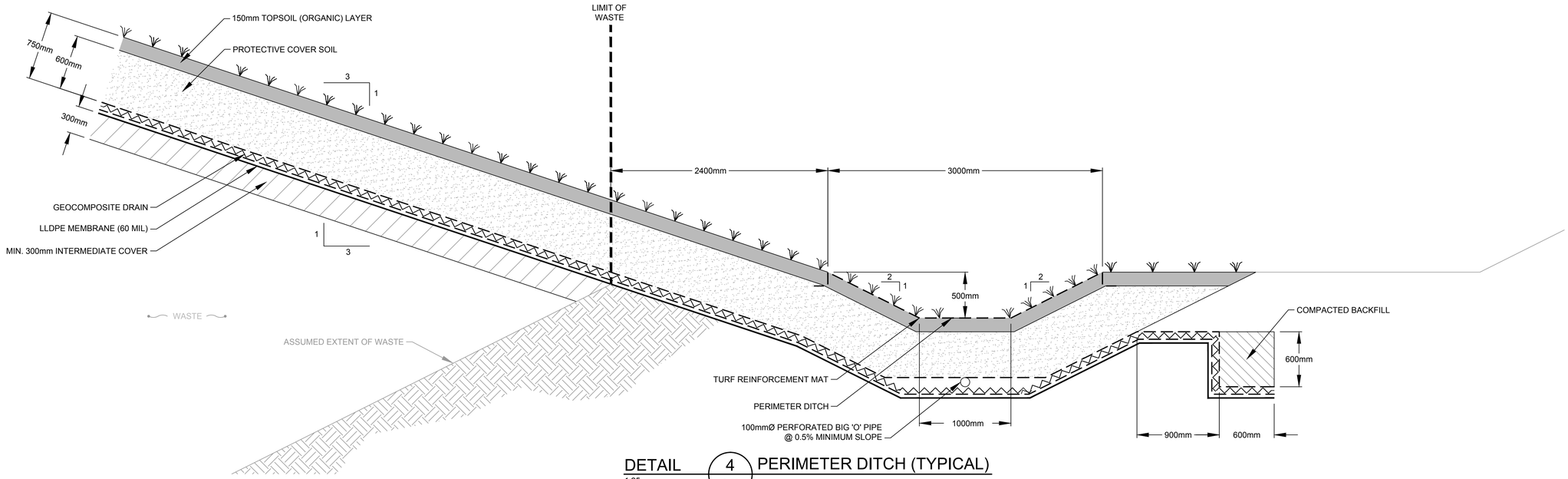
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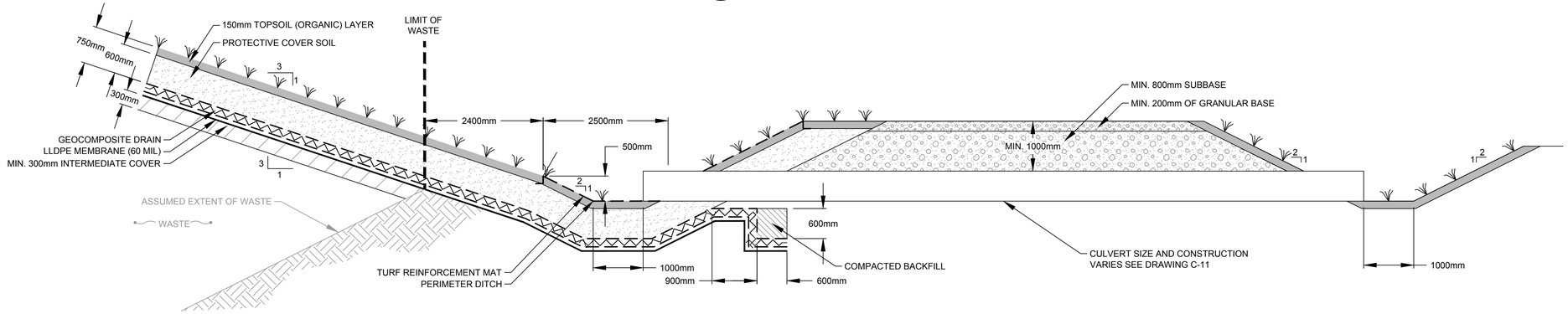
Title
DETAILS SHEET 1

Sheet No.
C-14

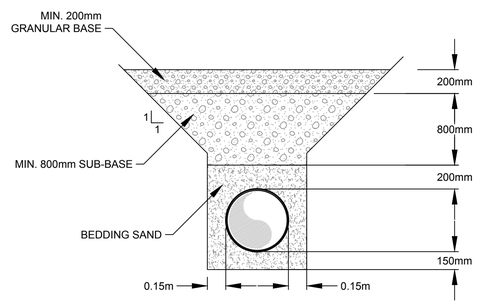
Sheet 15 of 17



DETAIL 4 PERIMETER DITCH (TYPICAL)
1:25 C-03



DETAIL 5 CULVERT
1:50 C-02



DETAIL 6 CULVERT (TYPICAL)
N.T.S. C-02

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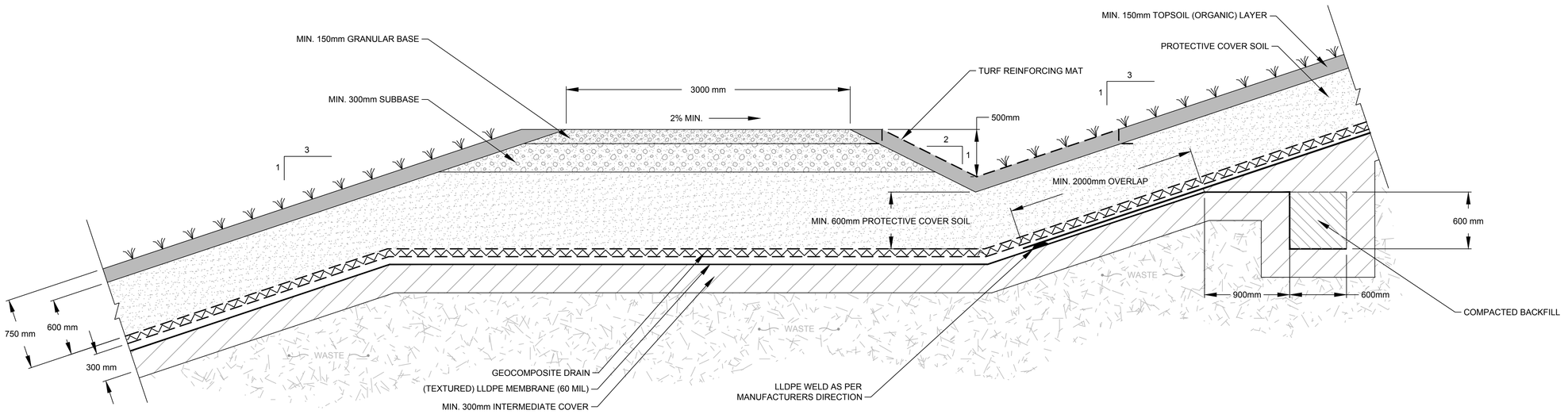
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 — 20mm

Project No. **56484-200**

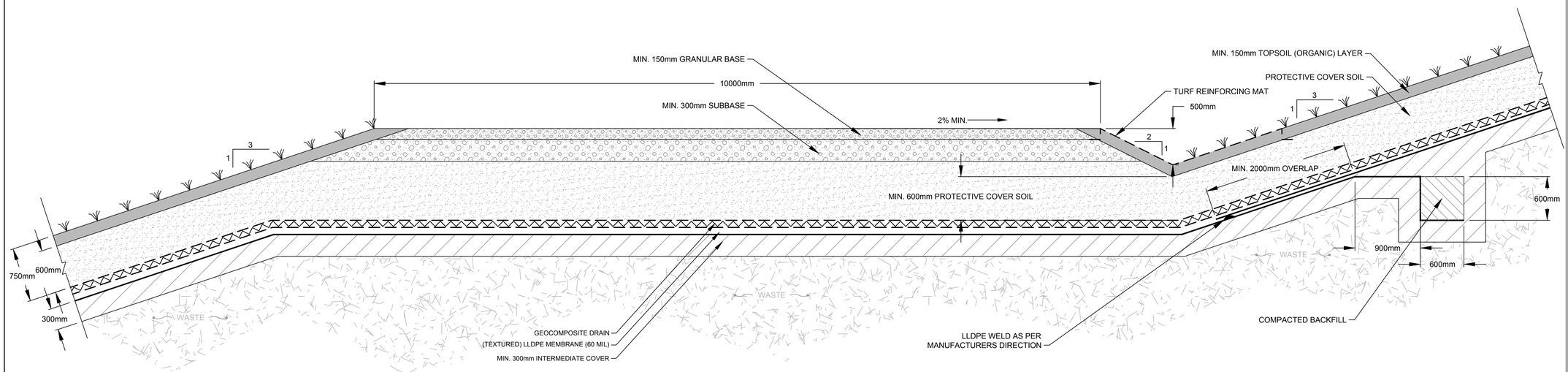
Title
DETAILS SHEET 2

Sheet No.
C-15

Sheet **16** of **17**



DETAIL 7 MID-SLOPE SWALE AND ACCESS ROAD
1:25 C-02



DETAIL 8 HAUL ROAD
1:30 C-02

GHD
10271 Shellbridge Way Suite 165
Richmond British Columbia V6X 2W8 Canada
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Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR MOE REVIEW	TW	GF	02/07/2018

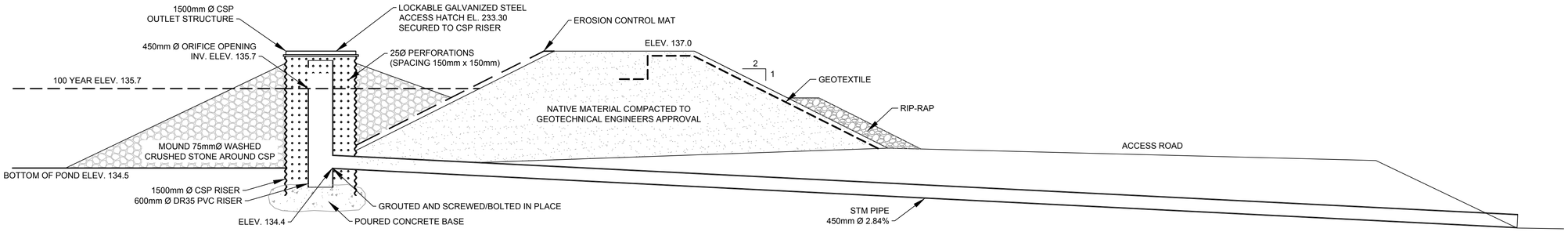
Drawn	K. RENNER	Designer	T.ELLIOT
Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN
Original Size	ANSI D	Bar is 20mm on original size drawing	0 — 20mm

Project No. **56484-200**

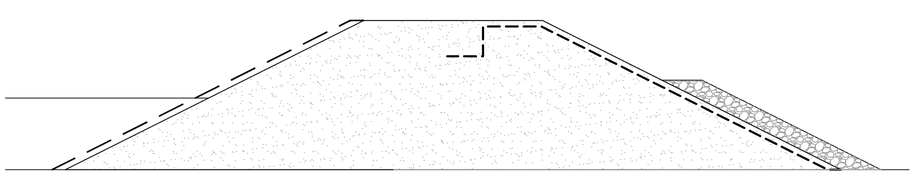
Title
DETAILS SHEET 3

Sheet No.
C-16

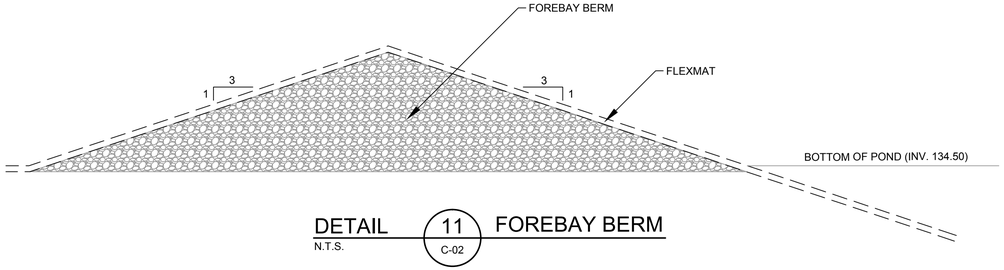
Sheet 17 of 17



DETAIL 9 OUTLET STRUCTURE
N.T.S. C-02



DETAIL 10 SURFACE WATER MANAGEMENT POND BERM
N.T.S. C-02



DETAIL 11 FOREBAY BERM
N.T.S. C-02

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Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
2017 DESIGN, OPERATIONS AND CLOSURE PLAN

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1	ISSUED FOR MOE REVIEW	TW	GF	02/07/2018

Drawn	T. WAGSTAFF	Designer	T.ELLIOT
Drafting Check	K. DHALIWAL	Design Check	D. LIDDY
Project Manager	G. FERRARO	Date	Feb 7, 2018
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 — 20mm
Project No.	56484-200		

Title
DETAILS SHEET 4

Sheet No.
C-17

Sheet 17 of 17

Appendices

Appendix A
Licence No. V922305 and Lease No. 103555

BRITISH COLUMBIA

January 30, 2017

Comox Valley Regional District
RECEIVED
File:
FEB 02 2017
To:
cc:

File: 12800-20/0307020

Comox Valley Regional District
600 Comox Road
Courtenay, BC
V9N 3P6

Dear Marc Rutten:

Attached is executed Licence No. V922305 dated for reference December 6, 2016 covering, BLOCK C, together with that part of BLOCK A, and that part of BLOCK K, all part of DISTRICT LOT 85, SAYWARD DISTRICT, containing 11.58 ha more or less.

This Licence is issued in the name of the Comox Valley Regional District, commencing December 6, 2016 for a two (2) year Term. It is issued for waste disposal site and associated drainage purposes.

A final Consent to Sub-tenure and Endorsement schedule has been attached to the Licence and will be held on file. These documents form an integral part of Licence V922305 and must be attached hereto.

Should you have any further questions, please contact me at (250) 286-9400.

Yours truly,

Shelley Jackson
Authorizations Administrator

Enclosures

pc: BC Assessment Authority,
Strathcona Regional District

Ministry of Forests, Lands and Natural Resource Operations | Campbell River Resource District | Mailing Address: 370 S. Dogwood St. Campbell River BC V9W 6Y7 | Tel: (250) 286-9300 Fax: (250) 286-9490 Website: www.for.gov.bc.ca/dcr

BRITISH COLUMBIA

LICENCE OF OCCUPATION

Licence No.: V922305

File No.: 0307020
Disposition No.: 922305

THIS AGREEMENT is dated for reference December 6, 2016 and is made under the *Land Act.*

BETWEEN:

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, represented by the minister responsible for the *Land Act*, Parliament Buildings, Victoria, British Columbia

(the "Province")

AND:

COMOX VALLEY REGIONAL DISTRICT
600 Comox Rd
Courtenay, BC V9N 3P6

(the "Licensee")

The parties agree as follows:

ARTICLE 1 - INTERPRETATION

1.1 In this Agreement,

"Agreement" means this licence of occupation;

"Commencement Date" means December 6, 2016;

"disposition" has the meaning given to it in the *Land Act* and includes a licence of occupation;

"Fees" means the fees set out in Article 3;

"Hazardous Substances" means any substance which is hazardous to persons, property or the environment, including without limitation

(a) waste, as that term is defined in the *Environmental Management Act*; and

(b) any other hazardous, toxic or other dangerous substance, the use, transportation or release into the environment of which, is now or from time to time prohibited, controlled or regulated under any laws or by any governmental authority, applicable to, or having jurisdiction in relation to, the Land;

"Improvements" includes anything made, constructed, erected, built, altered, repaired or added to, in, on or under the Land, and attached to it or intended to become a part of it, and also includes any clearing, excavating, digging, drilling, tunnelling, filling, grading or ditching of, in, on or under the Land;

"Land" means that part or those parts of the Crown land either described in, or shown outlined by bold line on, the schedule attached to this Agreement entitled "Legal Description Schedule" except for those parts of the land that, on the Commencement Date, consist of highways (as defined in the *Transportation Act*) and land covered by water;

"Landfill" means the Comox Valley Regional District's landfill located on Argonaut Road, Campbell River, British Columbia, to be constructed and operated on the Land pursuant to the Operational Certificate;

"Operational Certificate" means an operational certificate issued by the Minister responsible for the *Environmental Management Act*, authorizing or permitting the operation of a waste management facility on the Land, as amended from time to time;

"Realty Taxes" means all taxes, rates, levies, duties, charges and assessments levied or charged, at any time, by any government authority having jurisdiction which relate to the Land, the Improvements or both of them and which you are liable to pay under applicable laws;

"Security" means the security referred to in section 6.1 or 6.2, as replaced or supplemented in accordance with section 6.5;

"Solid Waste Management Plan" means the Solid Waste Management Plan approved by the Minister responsible for the *Environmental Management Act* authorizing the Landfill, as amended from time to time;

"Term" means the period of time set out in section 2.2;

"we", **"us"** or **"our"** refers to the Province alone and never refers to the combination of the Province and the Licensee: that combination is referred to as **"the parties"**; and

"you" or **"your"** refers to the Licensee.

1.2 In this Agreement, "person" includes a corporation, partnership or party, and the personal or other legal representatives of a person to whom the context can apply according to law and wherever the singular or masculine form is used in this Agreement it will be construed as the plural or feminine or neuter form, as the case may be, and vice versa where the context or parties require.

1.3 The captions and headings contained in this Agreement are for convenience only and do not define or in any way limit the scope or intent of this Agreement.

1.4 This Agreement will be interpreted according to the laws of the Province of British Columbia.

1.5 Where there is a reference to an enactment of the Province of British Columbia or of Canada in this Agreement, that reference will include a reference to every amendment to it, every regulation made under it and any subsequent enactment of like effect and, unless otherwise indicated, all enactments referred to in this Agreement are enactments of the Province of British Columbia.

1.6 If any section of this Agreement, or any part of a section, is found to be illegal or unenforceable, that section or part of a section, as the case may be, will be considered separate and severable and the remainder of this Agreement will not be affected and this Agreement will be enforceable to the fullest extent permitted by law.

1.7 Each schedule to this Agreement is an integral part of this Agreement as if set out at length in the body of this Agreement.

1.8 This Agreement constitutes the entire agreement between the parties and no understanding or agreement, oral or otherwise, exists between the parties with respect to the subject matter of this Agreement except as expressly set out in this Agreement and this Agreement may not be modified except by subsequent agreement in writing between the parties.

1.9 Each party will, upon the request of the other, do or cause to be done all lawful acts necessary for the performance of the provisions of this Agreement.

1.10 Any liabilities or obligations of either party arising, or to be performed, before or as a result of the termination of this Agreement, and which have not been satisfied or remain unperformed at the termination of this Agreement, any indemnity and any release in our favour and any other provision which specifically states that it will survive the termination of this Agreement, shall survive and not be affected by the expiration of the Term or the termination of this Agreement.

1.11 Time is of the essence of this Agreement.

1.12 Wherever this Agreement provides that an action may be taken, a consent or approval must be

obtained or a determination must be made, then you or we, as the case may be, will act reasonably in taking such action, deciding whether to provide such consent or approval or making such determination; but where this Agreement states that you or we have sole discretion to take an action, provide a consent or approval or make a determination, there will be no requirement to show reasonableness or to act reasonably in taking that action, providing that consent or approval or making that determination.

1.13 Any requirement under this Agreement for us to act reasonably shall not require us to act in a manner that is contrary to or inconsistent with any legislation, regulations, Treasury Board directives or other enactments or any policy, directive, executive direction or other such guideline of general application.

ARTICLE 2 - GRANT AND TERM

2.1 On the terms and conditions set out in this Agreement, we grant you a licence of occupation of the Land for waste disposal site and associated drainage works purposes, and you acknowledge this licence of occupation does not grant you exclusive use and occupancy of the Land.

2.2 The term of this Agreement commences on the Commencement Date and terminates on the 2nd anniversary of that date, or such earlier date provided for in this Agreement. We reserve the right to terminate this Agreement in certain circumstances as expressly provided in this Agreement.

2.3 If you

(a) are not in default under this Agreement;

(b) have delivered a written notice to us not later than 30 days prior to the expiration of this Agreement confirming that a boundary plan of the Land has been prepared and completed by a British Columbia Land Surveyor in compliance with instructions of the Surveyor General; and

(c) have paid to us the fees due under the *Land Act* for issuance of a Lease;

then we will grant to you a Lease over the Land described in the boundary plan, substantially on the terms and conditions set out in the form used by us at the time the "Lease" is being offered.

2.4 Our obligation to grant you a Lease under section 2.3 will cease if the form of Lease we deliver to you is not executed and returned to us within 60 days of the date of delivery.

2.5 The legal description to be inserted in the Lease under section 2.3 will be the description established by the Victoria Land Title Survey Authority.

2.6 If, after approval of the boundary plan referred to in section 2.3, we determine that the area of the land comprised within the boundary plan is greater than the area of the Land, then the fee specified in Article 3 will be adjusted at $0.00 per hectare to account for the greater area, and you will pay the additional fee to us upon issuance of the Lease.

ARTICLE 3 - FEES

3.1 The Fee for the Term is $1.00, the receipt of which we acknowledge.

ARTICLE 4 - COVENANTS

4.1 You must

(a) pay, when due,

(i) the Fees to us at the address set out in Article 10,

(ii) the Realty Taxes, and

(iii) all charges for electricity, gas, water and other utilities supplied to the Land for use by you or on your behalf or with your permission;

(b) deliver to us, immediately upon demand, receipts or other evidence of the payment of Realty Taxes and all other money required to be paid by you under this Agreement;

(c) observe, abide by and comply with

(i) all applicable laws, bylaws, orders, directions, ordinances and regulations of any government authority having jurisdiction in any way affecting your use or occupation of the Land or the Improvements including without limitation all laws, bylaws, orders, directions, ordinances and regulations relating in any way to Hazardous Substances, the environment and human health and safety, and

(ii) the provisions of this Agreement;

(d) in respect of the use of the Land by you or by any person who enters upon or uses the Land as a result of your use of the Land under this Agreement, keep the Land and the

Improvements in a safe, clean and sanitary condition satisfactory to us, and at our written request, rectify any failure to comply with such a covenant by making the Land and the Improvements safe, clean and sanitary;

(e) not commit any wilful or voluntary waste, spoil or destruction on the Land or do anything on the Land that may be or become a nuisance to an owner or occupier of land in the vicinity of the Land;

(f) use and occupy the Land only in accordance with and for the purposes set out in section 2.1;

(g) not construct, place or affix any Improvement on or to the Land except as necessary for the purposes set out in section 2.1;

(h) pay all accounts and expenses as they become due for work performed on or materials supplied to the Land at your request, on your behalf or with your permission, except for money that you are required to hold back under the *Builders Lien Act*;

(i) if any claim of lien over the Land is made under the *Builders Lien Act* for work performed on or materials supplied to the Land at your request, on your behalf or with your permission, immediately take all steps necessary to have the lien discharged, unless the claim of lien is being contested in good faith by you and you have taken the steps necessary to ensure that the claim of lien will not subject the Land or any interest of yours under this Agreement to sale or forfeiture;

(j) if any soil is disturbed by you as a result of your construction or maintenance of the Improvements, at your expense, restore the surface of the Land to a condition satisfactory to us;

(k) take all reasonable precautions to avoid disturbing or damaging any archaeological material found on or under the Land and, upon discovering any archaeological material on or under the Land, you must immediately notify the ministry responsible for administering the *Heritage Conservation Act*;

(l) permit us, or our authorized representatives, to enter on the Land at any time to inspect the Land and the Improvements, including without limitation to test and remove soil, groundwater and other materials and substances, where the inspection may be necessary or advisable for us to determine whether or not you have complied with your obligations under this Agreement with respect to Hazardous Substances, provided that we take reasonable steps to minimize any disruption of your operations;

(m) indemnify and save us and our servants, employees and agents harmless against all

claims, actions, causes of action, losses, damages, costs and liabilities, including fees of solicitors and other professional advisors, arising out of one or more of the following:

(i) any breach, violation or non-performance of a provision of this Agreement,

(ii) any conflict between your use of the Land under this Agreement and the lawful use of the Land by any other person, and

(iii) any personal injury, bodily injury (including death) or property damage occurring or happening on or off the Land by virtue of your entry upon, use or occupation of the Land,

and the amount of all such losses, damages, costs and liabilities will be payable to us immediately upon demand; and

(n) on the termination of this Agreement,

(i) peaceably quit and deliver to us possession of the Land and, subject to paragraphs (ii), (iii) and (iv), the Improvements in a safe, clean and sanitary condition,

(ii) within 60 days, remove from the Land any Improvement you want to remove, if the Improvement was placed on or made to the Land by you, is in the nature of a tenant's fixture normally removable by tenants and is not part of a building (other than as a tenant's fixture) or part of the Land and you are not in default of this Agreement,

(i) not remove any Improvement from the Land if you are in default of this Agreement, unless we direct or permit you to do so under paragraph (iv),

(iii) remove from the Land any Improvement that we, in writing, direct or permit you to remove, other than any Improvement permitted to be placed on or made to the Land under another disposition, and

(iv) restore the surface of the Land as nearly as may reasonably be possible, to the condition that the Land was in at the time it originally began to be used for the purposes described in this Agreement, but if you are not directed or permitted to remove an Improvement under paragraph (iii), this paragraph will not apply to that part of the surface of the Land on which that Improvement is located,

and all of your right, interest and estate in the Land will be absolutely forfeited to us, and to the extent necessary, this covenant will survive the termination of this

Agreement.

4.2 You will not permit any person who enters upon or uses the Land as a result of your use of the Land under this Agreement to do anything you are restricted from doing under this Article.

4.3 You must not use all or any part of the Land

(a) for the storage or disposal of any Hazardous Substances; or

(b) in any other manner whatsoever which causes or contributes to any Hazardous Substances being added or released on, to or under the Land or into the environment from the Land;

unless

(c) such storage, disposal, release or other use does not result in your breach of any other provision of this Agreement, including without limitation, your obligation to comply with all laws relating in any way to Hazardous Substances, the environment and human health and safety; and

(d) we have given our prior written approval to such storage, disposal, release or other use and for certainty

(i) our approval is hereby given for disposal of municipal solid waste in compliance with the Solid Waste Management Plan, Operational Certificate and all applicable laws; and

(ii) the approval in subparagraph (i) and any additional approvals only operate as an approval for the purposes of this section and does not bind, limit, or otherwise affect any other governmental authority from whom any consent, permit or approval may be required.

4.4 Despite any other provision of this Agreement you must:

(a) on the expiry or earlier termination of this Agreement; and

(b) at any time if we request and if you are in breach of your obligations under this Agreement relating to Hazardous Substances;

promptly remove from the Land all Hazardous Substances stored, or disposed of, on the Land, or which have otherwise been added or released on, to or under the Land:

(c) by you; or

(d) as a result of the use of the Land under this Agreement; or

(e) as a result of the use of the Land under the following prior agreements: Lease 101210, dated for reference May 17, 1986

save and except only to the extent that we have given a prior written approval expressly allowing specified Hazardous Substances to remain on the Land following the expiry of the Term, and for certainty our approval is hereby given for municipal solid waste deposited in compliance with the Solid Waste Management Plan, Operational Certificate and all applicable laws to remain on the Land following the expiry of the Term.

4.5 We may from time to time

(a) in the event of the expiry or earlier termination of this Agreement;

(b) as a condition of our consideration of any request for consent to an assignment of this Agreement; or

(c) if we have a reasonable basis for believing that you are in breach of your obligations under this Agreement relating to Hazardous Substances;

provide you with a written request to investigate the environmental condition of the Land and upon any such request you must promptly obtain, at your cost, and provide us with, a report from a qualified and independent professional who has been approved by us, as to the environmental condition of the Land, the scope of which must be satisfactory to us and which may include all such tests and investigations that such professional may consider to be necessary or advisable to determine whether or not you have complied with your obligations under this Agreement with respect to Hazardous Substances.

4.6 You must at our request from time to time, but not more frequently than annually, provide us with your certificate (and if you are a corporation such certificate must be given by a senior officer) certifying that you are in compliance with all of your obligations under this Agreement pertaining to Hazardous Substances, and that no adverse environmental occurrences have taken place on the Land, other than as disclosed in writing to us.

ARTICLE 5 - LIMITATIONS

5.1 You agree with us that

(a) in addition to the other reservations and exceptions expressly provided in this Agreement this Agreement is subject to the exceptions and reservations of interests, rights, privileges and titles referred to in section 50 of the *Land Act*;

(b) other persons may hold or acquire rights to use the Land in accordance with enactments other than the *Land Act* or the *Ministry of Lands, Parks and Housing Act*, including rights held or acquired under the *Coal Act, Forest Act, Geothermal Resources Act, Mineral Tenure Act, Petroleum and Natural Gas Act, Range Act, Water Sustainability Act* or *Wildlife Act* (or any prior or subsequent enactment of the Province of British Columbia of like effect); such rights may exist as of the Commencement Date and may be granted or acquired subsequent to the Commencement Date and may affect your use of the Land;

(c) other persons may hold or acquire interests in or over the Land granted under the *Land Act* or the *Ministry of Lands, Parks and Housing Act*; such interests may exist as of the Commencement Date; following the Commencement Date we may grant such interests (including fee simple interests, leases, statutory rights of way and licences); you acknowledge that your use of the Land may be affected by such interests and the area or boundaries of the Land may change as a result of the granting of such interests;

(d) you have no right to compensation from us and you release us from all claims, actions, causes of action, suits, debts and demands that you now have or may at any time in the future have against us arising out of any conflict between your use of the Land under this Agreement and any use of, or impact on the Land arising from the exercise, or operation of the interests, rights, privileges and titles described in subsections (a), (b), and (c);

(e) this Agreement does not limit any right to notice, compensation or any other benefit that you may be entitled to from time to time under the enactments described in subsection (b), or any other applicable enactment;

(f) you will not commence or maintain proceedings under section 65 of the *Land Act* in respect of any interference with your use of the Land as permitted under this Agreement that arises as a result of the lawful exercise or operation of the interests, rights, privileges and titles described in subsections (a), (b) and (c);

(g) maintain in good standing a valid Waste Management Permit from the Ministry of Environment;

(h) you will not remove or permit the removal of any Improvement from the Land except as expressly permitted or required under this Agreement;

(i) any interest you may have in the Improvements ceases to exist and becomes our property upon the termination of this Agreement, except where an Improvement may be removed under paragraph 4.1(n)(ii), (iii) or (iv) in which case any interest you may have in that Improvement ceases to exist and becomes our property if the Improvement is not removed from the Land within the time period set out in paragraph 4.1(n)(ii) or the time period provided for in the direction or permission given under paragraph 4.1(n)(iii); and

(j) if, after the termination of this Agreement, we permit you to remain in possession of the Land and we accept money from you in respect of such possession, a tenancy from year to year will not be created by implication of law and you will be deemed to be a monthly occupier only subject to all of the provisions of this Agreement, except as to duration, in the absence of a written agreement to the contrary.

ARTICLE 6 - SECURITY AND INSURANCE

6.1 On the Commencement Date, you will deliver to us Security in the amount of $0.00 which will

(a) guarantee the performance of your obligations under this Agreement;

(b) be in the form required by us; and

(c) remain in effect until we certify, in writing, that you have fully performed your obligations under this Agreement.

6.2 Despite section 6.1, your obligations under that section are suspended for so long as you maintain in good standing other security acceptable to us to guarantee the performance of your obligations under this Agreement and all other dispositions held by you.

6.3 We may use the Security for the payment of any costs and expenses associated with any of your obligations under this Agreement that are not performed by you or to pay any overdue Fees and, if such event occurs, you will, within 30 days of that event, deliver further Security to us in an amount equal to the amount drawn down by us.

6.4 After we certify, in writing, that you have fully performed your obligations under this Agreement, we will return to you the Security maintained under section 6.1, less all amounts drawn down by us under section 6.3.

6.5 You acknowledge that we may, from time to time, notify you to

(a) change the form or amount of the Security; and

(b) provide and maintain another form of Security in replacement of or in addition to the Security posted by you under this Agreement;

and you will, within 60 days of receiving such notice, deliver to us written confirmation that the change has been made or the replacement or additional form of Security has been provided by you.

6.6 You must

(a) without limiting your obligations or liabilities under this Agreement, at your expense, purchase and maintain during the Term the following insurance with insurers licensed to do business in Canada:

(i) Commercial General Liability insurance in an amount of not less than $2,000,000.00 inclusive per occurrence insuring against liability for personal injury, bodily injury (including death) and property damage, including coverage for all accidents or occurrences on the Land or the Improvements. Such policy will include cross liability, liability assumed under contract, provision to provide 30 days advance notice to us of material change or cancellation, and include us as additional insured;

(b) ensure that all insurance required to be maintained by you under this Agreement is primary and does not require the sharing of any loss by any of our insurers;

(c) within 10 working days of Commencement Date of this Agreement, provide to us evidence of all required insurance in the form of a completed "Province of British Columbia Certificate of Insurance";

(d) if the required insurance policy or policies expire or are cancelled before the end of the Term of this Agreement, provide within 10 working days of the cancellation or expiration, evidence of new or renewal policy or policies of all required insurance in the form of a completed "Province of British Columbia Certificate of Insurance";

(e) notwithstanding subsection (c) or (d) above, if requested by us, provide to us certified copies of the required insurance policies.

6.7 We may, acting reasonably, from time to time, require you to

(a) change the amount of insurance set out in subsection 6.6(a); and

(b) provide and maintain another type or types of insurance in replacement of or in addition to the insurance previously required to be maintained by you under this Agreement;

and you will, within 60 days of receiving such notice, cause the amounts and types to be changed and deliver to us a completed "Province of British Columbia Certificate of Insurance" for all insurance then required to be maintained by you under this Agreement.

6.8 You shall provide, maintain, and pay for any additional insurance which you are required by law to carry, or which you consider necessary to insure risks not otherwise covered by the insurance specified in this Agreement in your sole discretion.

6.9 You waive all rights of recourse against us with regard to damage to your own property.

ARTICLE 7 - ASSIGNMENT

7.1 You must not sublicense, assign, mortgage or transfer this Agreement, or permit any person to use or occupy the Land, without our prior written consent, which consent we may withhold.

7.2 Prior to considering a request for our consent under section 7.1, we may require you to meet certain conditions, including without limitation, that you provide us with a report as to the environmental condition of the Land as provided in section 4.5.

ARTICLE 8 - TERMINATION

8.1 You agree with us that

(a) if you

(i) default in the payment of any money payable by you under this Agreement, or

(ii) fail to observe, abide by and comply with the provisions of this Agreement (other than the payment of any money payable by you under this Agreement),

and your default or failure continues for 60 days after we give written notice of the default or failure to you,

(b) if, in our opinion, you fail to make diligent use of the Land for the purposes set out in this Agreement, and your failure continues for 60 days after we give written notice of the failure to you;

(c) if you

(i) become insolvent or make an assignment for the general benefit of your

creditors,

(ii) commit an act which entitles a person to take action under the *Bankruptcy and Insolvency Act* (Canada) or a bankruptcy petition is filed or presented against you or you consent to the filing of the petition or a decree is entered by a court of competent jurisdiction adjudging you bankrupt under any law relating to bankruptcy or insolvency, or

(iii) voluntarily enter into an arrangement with your creditors;

(d) if you are a corporation,

(i) a receiver or receiver-manager is appointed to administer or carry on your business, or

(ii) an order is made, a resolution passed or a petition filed for your liquidation or winding up;

(e) if you are a society, you convert into a company in accordance with the *Society Act* without our prior written consent;

(f) if this Agreement is taken in execution or attachment by any person; or

(g) if we require the Land for our own use or, in our opinion, it is in the public interest to cancel this Agreement and we have given you 60 days' written notice of such requirement or opinion;

this Agreement will, at our option and with or without entry, terminate and your right to use and occupy the Land will cease.

8.2 If the condition complained of (other than the payment of any money payable by you under this Agreement) reasonably requires more time to cure than 60 days, you will be deemed to have complied with the remedying of it if you commence remedying or curing the condition within 60 days and diligently complete the same.

8.3 You agree with us that

(a) you will make no claim against us for compensation, in damages or otherwise, upon the lawful termination of this Agreement under section 8.1; and

(b) our remedies under this Article are in addition to those available to us under the *Land Act*.

ARTICLE 9 - DISPUTE RESOLUTION

9.1 If any dispute arises under this Agreement, the parties will make all reasonable efforts to resolve the dispute within 60 days of the dispute arising (or within such other time period agreed to by the parties) and, subject to applicable laws, provide candid and timely disclosure to each other of all relevant facts, information and documents to facilitate those efforts.

9.2 Subject to section 9.5, if a dispute under this Agreement cannot be resolved under section 9.1, we or you may refer the dispute to arbitration conducted by a sole arbitrator appointed pursuant to the *Commercial Arbitration Act*.

9.3 The cost of the arbitration referred to in section 9.2 will be shared equally by the parties and the arbitration will be governed by the laws of the Province of British Columbia.

9.4 The arbitration will be conducted at our offices (or the offices of our authorized representative) in Campbell River, British Columbia, and if we or our authorized representative have no office in Campbell River, British Columbia, then our offices (or the offices of our authorized representative) that are closest to Campbell River, British Columbia.

9.5 A dispute under this Agreement in respect of a matter within our sole discretion cannot, unless we agree, be referred to arbitration as set out in section 9.2.

ARTICLE 10 - NOTICE

10.1 Any notice required to be given by either party to the other will be deemed to be given if mailed by prepaid registered mail in Canada or delivered to the address of the other as follows:

to us

MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
370 South Dogwood Street
Campbell River, BC V9W 6Y7;

to you

COMOX VALLEY REGIONAL DISTRICT
600 Comox Rd
Courtenay, BC V9N 3P6;

or at such other address as a party may, from time to time, direct in writing, and any such notice will be deemed to have been received if delivered, on the day of delivery, and if mailed, 7 days after the time of mailing, except in the case of mail interruption in which case actual receipt is required.

10.2 In order to expedite the delivery of any notice required to be given by either party to the other, a concurrent facsimile copy of any notice will, where possible, be provided to the other party but nothing in this section, and specifically the lack of delivery of a facsimile copy of any notice, will affect the deemed delivery provided in section 10.1.

10.3 The delivery of all money payable to us under this Agreement will be effected by hand, courier or prepaid regular mail to the address specified above, or by any other payment procedure agreed to by the parties, such deliveries to be effective on actual receipt.

ARTICLE 11 - MISCELLANEOUS

11.1 No provision of this Agreement will be considered to have been waived unless the waiver is in writing, and a waiver of a breach of a provision of this Agreement will not be construed as or constitute a waiver of any further or other breach of the same or any other provision of this Agreement, and a consent or approval to any act requiring consent or approval will not waive or render unnecessary the requirement to obtain consent or approval to any subsequent same or similar act.

11.2 No remedy conferred upon or reserved to us under this Agreement is exclusive of any other remedy in this Agreement or provided by law, but that remedy will be in addition to all other remedies in this Agreement or then existing at law, in equity or by statute.

11.3 The grant of a sublicence, assignment or transfer of this Agreement does not release you from your obligation to observe and perform all the provisions of this Agreement on your part to be observed and performed unless we specifically release you from such obligation in our consent to the sublicence, assignment or transfer of this Agreement.

11.4 This Agreement extends to, is binding upon and enures to the benefit of the parties, their heirs, executors, administrators, successors and permitted assigns.

11.5 If, due to a strike, lockout, labour dispute, act of God, inability to obtain labour or materials, law, ordinance, rule, regulation or order of a competent governmental authority, enemy or hostile action, civil commotion, fire or other casualty or any condition or cause beyond your reasonable control, other than normal weather conditions, you are delayed in performing any of your obligations under this Agreement, the time for the performance of that obligation will be extended by a period of time equal to the period of time of the delay so long as

(a) you give notice to us within 30 days of the commencement of the delay setting forth the nature of the delay and an estimated time frame for the performance of your obligation; and

(b) you diligently attempt to remove the delay.

11.6 You acknowledge and agree with us that

(a) this Agreement has been granted to you on the basis that you accept the Land on an "as is" basis;

(b) without limitation we have not made, and you have not relied upon, any representation or warranty from us as to

(i) the suitability of the Land for any particular use, including the use permitted by this Agreement;

(ii) the condition of the Land (including surface and groundwater), environmental or otherwise, including the presence of or absence of any toxic, hazardous, dangerous or potentially dangerous substances on or under the Land and the current and past uses of the Land and any surrounding land and whether or not the Land is susceptible to erosion or flooding;

(iii) the general condition and state of all utilities or other systems on or under the Land or which serve the Land;

(iv) the zoning of the Land and the bylaws of any government authority which relate to the development, use and occupation of the Land; and

(v) the application of any federal or Provincial enactment or law to the Land;

(c) you have been afforded a reasonable opportunity to inspect the Land or to carry out such other audits, investigations, tests and surveys as you consider necessary to investigate those matters set out in subsection (b) to your satisfaction before entering into this Agreement;

(d) you waive, to the extent permitted by law, the requirement if any, for us to provide you with a "site profile" under the *Environmental Management Act* or any regulations made under that act;

(e) we are under no obligation, express or implied, to provide financial assistance or to contribute toward the cost of servicing, creating or developing the Land or the Improvements and you are solely responsible for all costs and expenses associated with

your use of the Land and the Improvements for the purposes set out in this Agreement; and

(f) we are under no obligation to provide access or services to the Land or to maintain or improve existing access roads.

11.7 You agree with us that nothing in this Agreement constitutes you as our agent, joint venturer or partner or gives you any authority or power to bind us in any way.

11.8 This Agreement does not override or affect any powers, privileges or immunities to which you are entitled under any enactment of the Province of British Columbia.

The parties have executed this Agreement as of the date of reference of this Agreement.

SIGNED on behalf of **HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA**
by the minister responsible for the *Land Act*
or the minister's authorized representative

Minister responsible for the *Land Act*
or the minister's authorized representative

SIGNED on behalf of **COMOX VALLEY REGIONAL DISTRICT**
by its authorized signatories

Authorized Signatory

Authorized Signatory

LEGAL DESCRIPTION SCHEDULE

LEGAL DESCRIPTION: BLOCK C, together with that part of BLOCK A, and that part of BLOCK K, all part of DISTRICT LOT 85, SAYWARD DISTRICT shown on sketch in the following page, containing 11.58 ha more or less.

Legal Description Map of Lands File: 0307020

Natural Resource Region: West Coast **Natural Resource District:** DCR	**UTM** : Zone 10 **NAD** : 83	**DRAWN BY :** A. Smith **Date: 25/10/2016**
LAND DISTRICT : Sayward District **BCGS MAPSHEET NO :092K004**	**SCALE** : 1:10,000 **Area Ha's :** + / - 11.58 ha's	**Dispostion ID: 922305** **Parcel #: 947644**

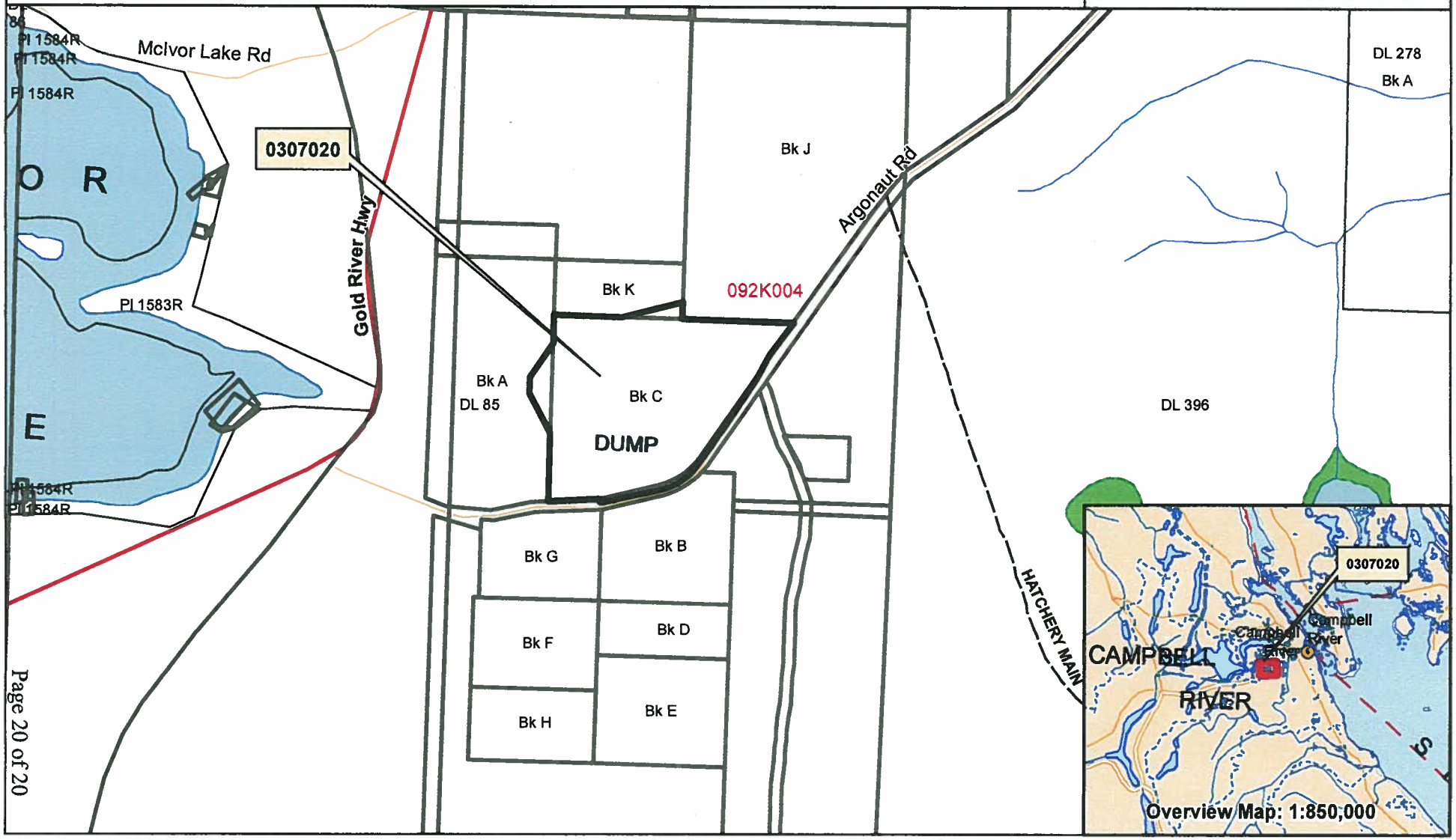
Ministry of Forests, Lands and Natural Resource Operations

N

Legal Description:

BLOCK C, together with that part of BLOCK A, and that part of BLOCK K, all part of DISTRICT LOT 85, SAYWARD DISTRICT shown on sketch below containing 11.58 ha more or less.

BRITISH COLUMBIA



BRITISH COLUMBIA

Ministry of Forests,
Lands and Natural
Resource Operations

Consent to Sub-Tenure

Licence No.: V922305 File No.: 0307020

CONSENT TO SUB-TENURE

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, as represented by the Minister responsible for the *Land Act* (the "Province") tenured the use of the following described land to the Comox Valley Regional District by way of a Licence dated the 6th day of December, 2016 :

BLOCK C, together with that part of BLOCK A, and that part of BLOCK K, all part of DISTRICT LOT 85, SAYWARD DISTRICT, containing 11.58 ha more or less.

In accordance with Article 7 of the Licence, the tenure-holder has asked the Province to consent to a sub-tenure to the City of Campbell River (the "sub-tenure-holder").

The Province hereby consents to the sub-tenure by the tenure-holder in favour of the sub-tenure-holder on the following terms and conditions:

1. the Province's consent to the sub-tenure will not be deemed to waive or modify the rights of the Province under the Licence; and

2. the provisions of Article 7 of the Licence restricting the tenure-holder from assigning, mortgaging, subletting or transferring the lease without the prior written consent of the Province remains in full force and effect.

The Province's consent to the sub-tenure given this 27th day of January 2017.

Duly Authorized Signatory of
HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, as represented by the Minister responsible for the *Land Act*

BRITISH COLUMBIA

Ministry of Forests, Lands and Natural Resource Operations

ENDORSEMENTS

Licence No: V922305 File No.:0307020
Endorsement No.: 1 Date: January 27, 2017

Portions sub-let unto the City of Campbell River for a term expiring December 5, 2018.

Authorized Representative

BRITISH COLUMBIA

5360.20 | CR.

July 17, 2013

File: 1405218

Comox Valley Regional District
600 Comox Road
Courtenay BC V9N 3P6

Attention: Vince Van Tongeren, Engineering Analyst

Dear Sir:

Enclosed is a certified true copy of Lease No.103555, covering Block J of District Lot 85, Sayward District, endorsed with the assignment dated January 18, 2012.

From: City of Campbell River

To: Comox Valley Regional District
600 Comox Road
Courtenay BC V9N 3P6

A copy of the Assignment/Assumption agreement has been inserted in the Lease document.

Please do not hesitate to call me at (250) 751-3175, if you have any questions.

Yours truly,

Barb Creber
A/Portfolio Administrator

Enclosure

pc: BC Assessment Authority, Courtenay
Ministry of Environment, EPD Nanaimo

Ministry of Forests, Lands
And Natural Resource Operations

West Coast Region

Suite 142 – 2080 Labieux Rd
Nanaimo BC V9T 6J9
Phone: (250) 751-7220
Fax: (250) 751-7224

BRITISH COLUMBIA

ASSIGNMENT/ASSUMPTION

Lease. No.: 103555

File No.: 1405218
Disposition No.: 157316

THIS AGREEMENT is dated for reference January 18, 2012.

BETWEEN:

CITY OF CAMPBELL RIVER
301 St Ann's Rd
Campbell River, BC V9W 4C7

OF THE FIRST PART

(herein the "Assignor")

AND:

COMOX VALLEY REGIONAL DISTRICT
600 Comox Road
Courtenay, BC V9N 3P6

OF THE SECOND PART

(herein the "Assignee")

AND:

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, represented by the minister responsible for the *Land Act*, Parliament Buildings, Victoria, British Columbia

OF THE THIRD PART

(herein the "Province")

WITNESS THAT WHEREAS:

The Assignor and the Province entered into a agreement dated May 17, 1991 (herein called the "Document") over those lands more particularly known and described as:

BLOCK J OF DISTRICT LOT 85, SAYWARD DISTRICT

NOW THEREFORE THIS AGREEMENT WITNESSETH that for good and valuable consideration paid by the Assignee to the Assignor and by the Assignee and the Assignor to the Province, the receipt and sufficiency of which is hereby acknowledged by both the Assignor and the Province, the parties agree as follows:

ARTICLE I - ASSIGNMENT

1.1 The Assignor assigns all of his right, title, interest and estate in and to the Document to the Assignee.

ARTICLE II - ASSUMPTION

2.1 The Assignee covenants with the Province to assume and be bound by all the terms, conditions, covenants, obligations and agreements contained in the Document.

ARTICLE III - CONSENT

3.1 The Province consents to the execution and delivery of this agreement and the Assignment.

3.2 The Province releases and discharges the Assignor from all the terms, conditions, covenants, obligations and agreements contained in the Document.

ARTICLE IV - WARRANTIES AND REPRESENTATIONS

4.1 The Assignee warrants and represents to the Province, with the intent that the Province will rely thereon, that the Assignee:

(a) is a district or municipality incorporated under the *Local Government Act* and has the legal capacity to acquire land.

4.2 The Assignee acknowledges to the Province and to the Assignor that:

(a) the Assignee has inspected the land, and the improvements (if any) situate thereon, which are the subject of the Document and is fully aware of the condition of that land, and the improvements (if any) situate thereon, and accepts same in its current state;

(b) the Assignee has reviewed and inspected all municipal and regional by-laws, regulations and policies concerning the use and development of the land which is the subject of the Document; and

(c) there are no representations, warranties, collateral agreements or conditions affecting this agreement or the land, and the improvements (if any) situate thereon, which are the subject of the Document except as expressed herein and that this agreement constitutes the entire agreement.

ARTICLE V - NOTICE

5.1 The address of the Assignee for the service of notices or documents under the Document shall be the address specified for the Assignee on the first page of this agreement.

ARTICLE VI - MISCELLANEOUS

6.1 This agreement shall enure to the benefit of the parties hereto and their respective successors and permitted assigns.

6.2 The parties to this agreement confirm that the terms of the Document remain and continue in full force and effect.

6.3 This agreement may not be assigned by the Assignee except in accordance with the provisions of the Document.

6.4 This agreement shall be governed by and construed in accordance with the laws of the Province of British Columbia.

6.5 In this agreement, unless the context otherwise requires, the singular includes the plural and the masculine includes the feminine gender and corporation as the case may be.

6.6 The captions and headings contained in this agreement are for convenience only and are not to be construed as defining or in anyway limiting the scope or intent of the provisions hereof.

6.7 Where there is a reference to an enactment of the Province of British Columbia in this agreement, that reference shall include a reference to any subsequent enactment of the Province of British Columbia of like effect, and, unless the context otherwise requires, all statutes referred to herein are enactments of the Province of British Columbia.

6.8 If any section of this agreement or any part of a section is found to be illegal or unenforceable, that part or section as the case may be, shall be considered separate and severable and the remaining parts shall be enforceable to the fullest extent permitted by law.

6.9 All schedules attached to this agreement form an integral part of this agreement.

IN WITNESS WHEREOF the Assignor and Assignee have executed this agreement, and the Province has consented thereto, the day and year first above written.

SIGNED on behalf of **HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA** by the minister responsible for the *Land Act* or the minister's authorized representative

Minister responsible for the *Land Act*
or the minister's authorized representative

SIGNED on behalf of **CITY OF CAMPBELL RIVER** by its authorized signatories

Authorized Signatory DAVID G. MORRIS GENERAL MANAGER, FACILITIES & SUPPLY MANAGEMENT

Authorized Signatory Tracy Bate Deputy City Clerk

SIGNED on behalf of **COMOX VALLEY REGIONAL DISTRICT** by its authorized signatories

Authorized Signatory

Authorized Signatory

IN WITNESS WHEREOF the Assignor and Assignee have executed this agreement, and the Province has consented thereto, the day and year first above written.

SIGNED on behalf of **HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA**
by the minister responsible for the *Land Act*
or the minister's authorized representative

Minister responsible for the *Land Act*
or the minister's authorized representative

SIGNED on behalf of
CITY OF CAMPBELL RIVER
by its authorized signatories

Authorized Signatory DAVID MORRIS

Authorized Signatory

SIGNED on behalf of **COMOX VALLEY REGIONAL DISTRICT**
by its authorized signatories

Authorized Signatory

Authorized Signatory

CERTIFIED TRUE COPY
Date July 17/13 Signature

For Land Title Office use: Page ___ of ___.

Province of British Columbia
Ministry of Crown Lands

Lease

Lease No. 103555 File No. 1405218

THIS LEASE dated for reference the 17th day of May, 1991.

IN PURSUANCE OF THE *LAND ACT* (Section 35) and the *LAND TRANSFER FORM ACT*

BETWEEN:

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, represented by the Minister of Crown Lands, Parliament Buildings, Victoria, British Columbia

(hereinafter called the " Lessor")

OF THE FIRST PART

AND:

District Of Campbell River
301 St. Ann's Road
Campbell River, British Columbia
V9W 4C7

(hereinafter called the " Lessee")

OF THE SECOND PART

WITNESS THAT WHEREAS the Lessor has agreed to grant to the Lessee a lease over that parcel of land described in the schedule attached entitled Legal Description (hereinafter called the "Land");

NOW THEREFORE in consideration of the fee to be paid by, and the covenants of the Lessee, the parties agree as follows:

Article I - Grant of Lease

(1.01) The Lessor, on the terms set forth herein, hereby demises and leases to the Lessee the Land, save and except those portions of the Land that consist of trails, roads, highways, water courses, or that are covered by water at the date hereof, for ***sanitary landfill purposes***

Article II - Term

(2.01) TO HAVE AND TO HOLD the Land unto the Lessee for a ***term of 30 years commencing on the 17th day of May, 1991*** (hereinafter called the "Commencement Date").

CERTIFIED TRUE COPY
Date July 17/13 Signature

Lease 103555 File No. 1405218

Article III - Fees

(3.01) YIELDING AND PAYING THEREFORE for the term the fee prescribed in the attached Fee Schedule.

Article IV - Covenants of the Lessee

(4.01) The Lessee covenants with the Lessor

(a) to pay fees when due at the address of the Lessor first above written or at such other place as the Lessor may specify by notice in writing;

(b) to pay and discharge when due all applicable taxes, levies, charges and assessments now or hereafter assessed, levied or charged which relate to the Land or any improvements thereon (herein called "Realty Taxes");

(c) to observe, abide by and comply with all applicable laws, bylaws, orders, directions, ordinances and regulations of any competent governmental authority in any way affecting the Land and improvements situate thereon, or their use and occupation;

(d) to keep the Land in a safe, clean and sanitary condition satisfactory to the Lessor, and on written notice from the Lessor to make safe, clean and sanitary any portion of the Land or any improvements that, in the opinion of the Lessor, contravenes the provisions of this covenant;

(e) not to commit or suffer any willful or voluntary waste, spoil or destruction on the Land or to do or suffer to be done thereon anything that may be or become a nuisance or annoyance to the owners or occupiers of adjoining land;

(f) to use and occupy the Land in accordance with the provisions of this lease and any Special Proviso Schedule;

(g) to effect and keep in force during the term, insurance protecting the Lessor and the Lessee (without any rights of cross-claim or subrogation against the Lessor) against claims for personal injury, death, property damage, third party or public liability claims arising from any accident or occurrence on the Land or improvements up to an amount not less than $1,000,000.00, PROVIDED, however that the Lessor may, in his sole discretion, waive the requirements of this subsection on the delivery to the Lessor of evidence that the Lessee is self insured;

(h) to deliver to the Lessor from time to time, upon demand, proof of insurance required to be maintained by the Lessee, receipts or other evidence of payment of Realty Taxes, insurance premiums, leasehold mortgage installments or other monetary obligations of the Lessee required to be observed by the Lessee pursuant to this lease;

(i) notwithstanding subsection (g) of section 4.01, the Lessor may from time to time notify the Lessee that the amount of insurance posted by the Lessee pursuant to that subsection be changed and the Lessee shall, within 60 days of receiving such notice, cause the amount of insurance posted pursuant to subsection (g) of section 4.01 to be changed to the amount specified in the notice and deliver to the Lessor written confirmation of the change, except that when the Lessee is self-insuring this section shall not apply;

(j) to indemnify and save the Lessor harmless against all loss, damages, costs and liabilities, including fees of solicitors and other professional advisors arising out of

(i) any breach, violation or non-performance of any covenant, condition or agreement in this lease by the Lessee,

CERTIFIED TRUE COPY
Date July 17/13 Signature

(ii) any personal injury, death or property damage occurring on the Land or happening by virtue of the Lessee's use or occupation of the Land,

and the Lessor may add the amount of such loss, damages, costs and liabilities to the fees and the amount so added shall be payable to the Lessor immediately;

(k) to pay all accounts and expenses for labour performed on, or material supplied to, the Land, in accordance with the ***Builders Lien Act*** , and on behalf of the Lessor, to place written notices immediately after the commencement of any construction on the Land, on at least two conspicuous places, giving notice that the Lessor shall not be responsible for the cost of labour, services or materials performed on or supplied to the Land;

(l) on the expiration or earlier cancellation of this lease

(i) to peaceably quit and deliver possession of the Land and any improvements thereon to the Lessor, in a safe and sanitary condition,

(ii) to restore the surface of the Land to the satisfaction of the Lessor, AND

(iii) notwithstanding section 4.01 (l) (i) to remove any improvements that the Lessor may, in writing, direct or permit to be removed,

and all right, interest and estate of the Lessee shall cease and vest in the Lessor, and to the extent necessary this covenant shall survive the expiration or earlier cancellation of this lease;

(m) to permit the Lessor, or his authorized representative, to enter upon the Land at anytime to inspect the Land and any improvements thereon.

Article V - Assignment

(5.01) The Lessee shall not assign, mortgage, sublet or transfer this lease without the prior consent of the Lessor.

Article VI - Covenants of the Lessor

(6.01) The Lessor covenants with the Lessee for quiet enjoyment.

Article VII - Provisos

(7.01) PROVIDED always and it is hereby agreed as follows:

(a) if, after the termination by the passage of time of this lease or any extension thereof, the Lessor permits the Lessee to remain in possession of the Land and accepts rent in respect thereof, a tenancy from year to year shall not be created by implication of law and the Lessee shall be deemed to be a monthly tenant only subject to all of the terms and conditions of this lease, except as to duration in the absence of a written agreement to the contrary;

(b) title to and ownership of all buildings, structures and other improvements now or hereafter constructed on the Land shall be vested in the Lessor and the Lessee shall neither remove nor permit the removal of them from the Land except as expressly permitted or required by this lease;

(c) the Lessor is under no obligation to provide access or services to the Land or to maintain or improve existing access roads;

(d) the Lessor hereby reserves the right to grant other dispositions of the Land, or any part of it, with the prior consent of the Lessee, which consent shall not be unreasonably withheld, by way of easement, right of way or statutory right of way to a Crown corporation or agency, a municipality, or regional district,

CERTIFIED TRUE COPY
Date July 17/13 Signature

or a person or corporation and, upon such consent being given, the Lessee shall forthwith execute and deliver to the Lessor such instrument as may be necessary to subordinate the Lessee's right and interest in the Land under this lease;

(e) for the purpose of subsection (d) of section 7.01, the Lessee shall be deemed to have withheld his consent reasonably if a grant of rights under that subsection would materially affect the exercise of the Lessee's rights hereunder;

(f) if a dispute should arise as to whether or not the exercise of the Lessee's rights hereunder would, in fact, be materially affected by a grant of rights under subsection (d) of section 7.01, then, the dispute shall be referred to a sole arbitrator appointed pursuant to the ***Commercial Arbitration Act***;

(g) the Lessee hereby acknowledges and agrees that no claim for compensation shall be made, in any form, in respect of a grant of rights under subsection (d) of section 7.01, where such rights do not materially affect the exercise of the Lessee's rights hereunder;

(h) this lease and the term herein granted is subject to:

(i) all subsisting grants to or rights of any person made or acquired under the ***Coal Act, Forest Act, Mineral Tenure Act, Petroleum and Natural Gas Act, Range Act, Wildlife Act*** , or ***Water Act*** , or any extension or renewal of the same, whether or not the Lessee has actual notice of them, AND

(ii) the exceptions and reservations of rights, interests, privileges and titles referred to in section 47 of the ***Land Act:***

(i) the Lessee acknowledges and agrees with the Lessor that

(i) any interference with the rights of the Lessee under this lease by virtue of the exercise or operation of the rights, privileges or interests described in subsections (d) and (h) of section 7.01 shall not constitute a breach of the Lessor's covenant of quiet enjoyment and the Lessee releases and discharges the Lessor from and against any claims for loss or damage arising directly or indirectly out of any such interference,

(ii) all costs and expenses, direct or indirect, that arise out of any interference by the Lessee with the rights, privileges and interests described in subsections (d) and (h) of section 7.01 shall be borne solely by the Lessee,

(iii) he shall not commence or maintain proceedings under section 60 of the ***Land Act*** in respect of any interference with his rights hereunder arising directly or indirectly out of the exercise or operation of the right, privileges or interests described in subsections (d) and (h) of section 7.01, AND

(iv) all schedules attached to this lease form an integral part of this lease.

Article VIII - Events of Default

(8.01) PROVIDED ALSO that this lease and the term and estate hereby granted are subject to the limitation that

(a) if the Lessee shall default in the payment of any installment of fees, or the payment of any other sum payable hereunder, and such default shall continue for 60 days after the giving of written notice by the Lessor to the Lessee;

(b) if the Lessee shall fail to perform or observe any of the covenants, agreements, conditions or provisos contained in this lease on the part of the Lessee to be performed or observed (other than the payment of fees or other sums of money) and such failure shall continue for, or shall not be remedied within, the period of 60 days next after the giving of written notice by the Lessor to the Lessee of the nature of such failure;

CERTIFIED TRUE COPY
Date July 17/13 Signature

Lease 103555	File No. 1405218

(c) if the term hereby granted shall be taken in execution or attachment by any person or the Lessee commits an act of bankruptcy, becomes insolvent or is petitioned into bankruptcy or voluntarily enters into an arrangement with his creditors;

(d) if the Lessor discovers that the Lessee either in his application for this lease or otherwise has, in the opinion of the Lessor, misrepresented or withheld any fact material to the application; OR

(e) if, in the opinion of the Lessor, the Lessee fails to make reasonable and diligent use of the Land for the purposes permitted herein, and such failure shall continue for a period of 60 days next after the Lessor gives written notice of the failure to the Lessee;

it shall then be lawful for the Lessor to enter upon the Land or any part thereof in the name of the whole, and this lease shall at the option of the Lessor, and with or without entry, terminate, and all the rights of the Lessee with respect to the Land shall be absolutely forfeited and shall lapse. If the condition complained of (other than the payment of fees or other sums of money) reasonably requires more time to cure than 60 days, the Lessee shall be deemed to have complied with the remedying thereof if the Lessee shall have commenced remedying or curing the condition within the 60 day period and diligently thereafter completes the same.

Article IX - Security

(9.01) The security in the sum of $0.00 and all rights, privileges, benefits and interests accruing thereto delivered by the Lessee to the Lessor (herein called the "Security") to guarantee the performance of the Lessee's obligations under this lease shall be maintained in effect until such time as the Lessor certifies in writing that such obligations have been fully performed; PROVIDED, however, that the Lessor may, in his sole discretion, waive the requirements of this subsection.

(9.02) In the event the Lessee should default in the performance of any of his obligations hereunder, it shall be lawful for the Lessor, in his sole discretion, to sell, call in and convert the Security, or any part of it, and such Security shall be deemed to have been absolutely forfeited to the Lessor.

(9.03) The rights of the Lessor under this Article shall be deemed to continue in full force and effect notwithstanding the expiration or earlier cancellation of this lease.

(9.04) Notwithstanding section 9.01, the Lessor may from time to time notify the Lessee that the amount of Security delivered by the Lessee to the Lessor be changed and specify the amount of Security required by the Lessor.

(9.05) The Lessee shall, within 60 days of receiving the notice referred to in section 9.04, cause the amount of security delivered to the Lessor to be changed to the amount specified in the notice and provide the Lessor with written confirmation of the change.

Article X - Notice

(10.01) Where service of a notice or a document is required under this lease the notice or document shall be in writing and shall be deemed to have been delivered to, or if sent by prepaid registered mail addressed to, the Lessor and the Lessee at the addresses specified for each in this lease, and where service is by registered mail the notice or document shall be conclusively deemed to have been served on the eighth day after its deposit in a Canada Post office at any place in Canada.

CERTIFIED TRUE COPY
Date July 17/18 Signature

Lease 103555 File No. 1405218

(10.02) Either party may, by notice in writing to the other, specify another address for service of notices under this lease, and where another address is specified under this section, notices shall be mailed to that address in accordance with this Article.

(10.03) Notwithstanding section 10.01, any written notice to be served or given by the Lessor to the Lessee under this lease shall be effectively given or served by posting the same in a conspicuous place on the Land.

Article XI - Miscellaneous

(11.01) No term, condition, covenant or other provision herein shall be considered to have been waived by the Lessor unless such waiver is expressed in writing by the Lessor. Any such waiver of any term, condition, covenant or other provision herein shall not be construed as or constitute a waiver of any further or other breach of the same or any other term, condition, covenant, or other provision and the consent or approval of the Lessor to any act by the Lessee requiring the consent or approval of the Lessor shall not be considered to waive or render unnecessary such consents or approvals to any subsequent same or similar act by the Lessee.

(11.02) No remedy conferred upon or reserved to the Lessor is exclusive of any other remedy herein or provided by law, but such remedy shall be cumulative and shall be in addition to any other remedy herein or hereafter existing at law, in equity, or by statute.

(11.03) The terms and provisions of this lease shall extend to, be binding upon and enure to the benefit of the parties hereto and their successors and permitted assigns.

(11.04) Time is of the essence in this agreement.

Article XII - Interpretation

(12.01) In this lease, unless the context otherwise requires, the singular includes the plural and the masculine includes the feminine gender and a corporation.

(12.02) The captions and headings contained in this lease are for convenience only and are not to be construed as defining or in any way limiting the scope or the intent of the provisions hereof.

(12.03) Where this lease contains the forms of words contained in Column I of Schedule 4 of the ***Land Transfer Form Act,*** those words shall have the same effect and be construed as if the appropriate forms of words contained in Column II of that Schedule were contained herein in their place, unless the context requires another construction of those words.

(12.04) Where in this lease there is a reference to an enactment of the Province of British Columbia or of Canada, that reference shall include a reference to any subsequent enactment of like effect, and unless the context otherwise requires, all statutes referred to herein are enactments of the Province of British Columbia.

(12.05) If any section of this lease or any part of a section is found to be illegal or unenforceable, that part or section, as the case may be, shall be

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Date July 17/18 Signature

For Land Til Office use: Page ___ of ___.

Lease 103555	File No. 1405218

considered separate and severable and the remaining parts or sections, as the case may be, shall not be affected thereby and shall be enforceable to the fullest extent permitted by law.

IN WITNESS WHEREOF the parties have executed this lease as of the day and year first above written.

SIGNED on behalf of Her Majesty the Queen in Right of the Province of British Columbia by a duly authorized representative in the presence of:

E A Fullerton
851 Yates St.
Victoria

Authorized Representative

THE COMMON SEAL of Corporation Of The District Of Campbell River was hereunto affixed in the presence of

Robert V Patten MAYOR
Authorized Signatory

CLERK
Authorized Signatory

c/s

CERTIFIED TRUE COPY

Date July 8/13 Signature [signature]

For Land Title Office use: Page ___ of ___.

Province of British Columbia
Ministry of Crown Lands

Legal Description Schedule

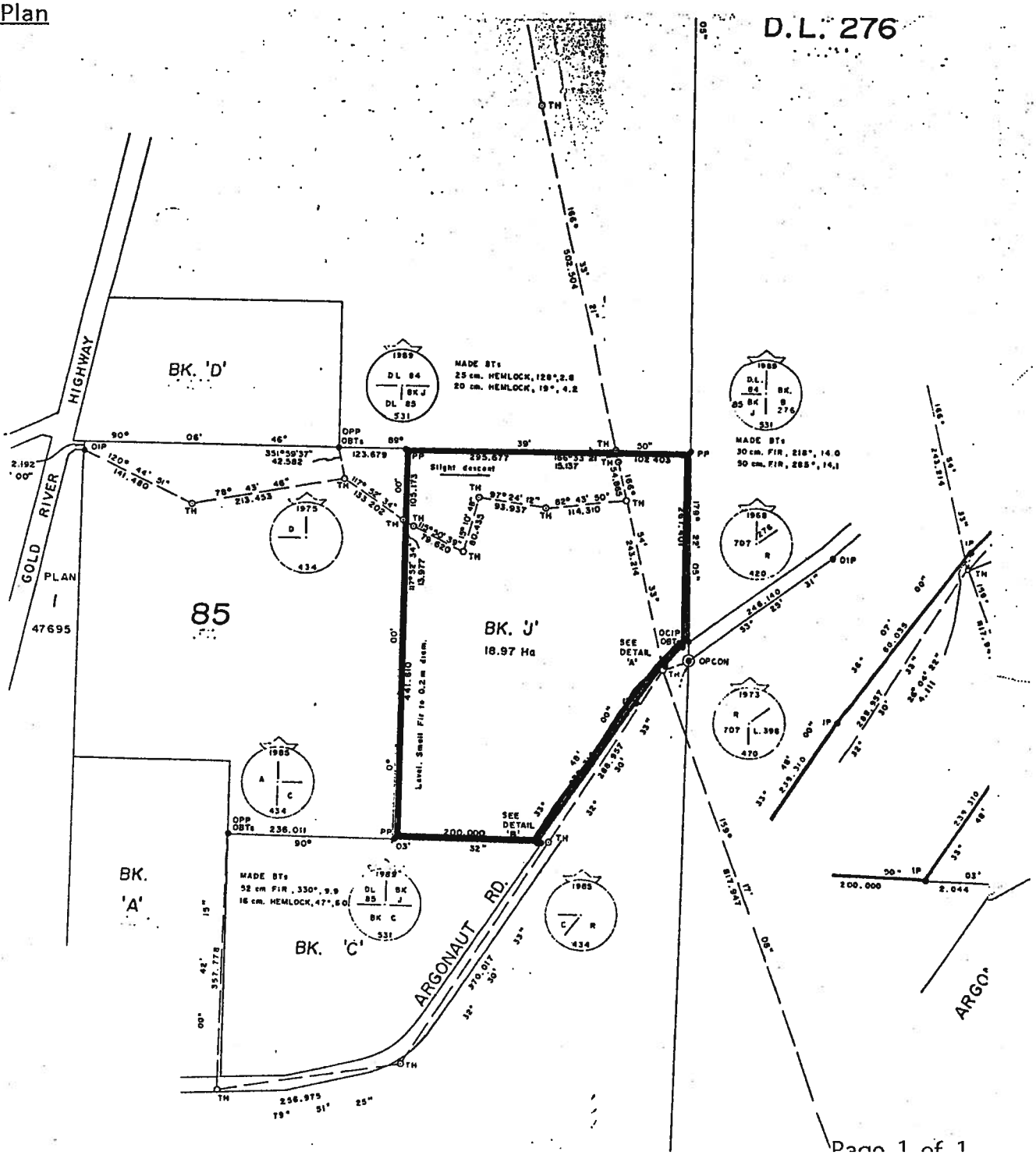
Lease No. 103555

File No. 1405218

1. Legal Description

Block J of District Lot 85, Sayward District as shown outlined in red on the sketch attached and containing 18.97 hectares.

2. Sketch Plan



CERTIFIED TRUE COPY

Date July 17/13 Signature

For Land Title Office use: Page ___ of ___.

Province of British Columbia
Ministry of Crown Lands

SPECIAL PROVISO SCHEDULE

Lease No. 103555 File No. 1405218

1. The Lessee shall:

   (a) Not undertake any improvement on the Land, except as provided for in this Lease, without the prior written consent of the Lessor.

   (b) Adhere to the provisions of his Waste Management permit issued by the Ministry of Environment.

2. ADDITIONAL PROVISOS

   (a) The Lessee shall obtain a License to Cut from the Ministry of Forests before proceeding with clearing the Land.

CERTIFIED TRUE COPY

Date July 7/13 Signature

For Land Title Office use: Page ___ of ___.

Province of British Columbia
Ministry of Crown Lands

FEE SCHEDULE

Lease No. 103555 File No. 1405218

THE FEE FOR THE TERM SHALL BE the sum of $1.00, payable in advance, on the Commencement Date.

CERTIFIED TRUE COPY

Date July 17/13 Signature

BRITISH COLUMBIA

Ministry of
Agriculture and Lands

ENDORSEMENTS

Lease No: 103555
Endorsement No.: 1

File No.: 1405218
Date: December 9, 2005

Lease recorded in the name of the City of Campbell River as of April 4, 2005 pursuant to Letters of Patent issued under Authority of the Local Government Act.

Authorized Representative

BRITISH COLUMBIA

Ministry of Forests, Lands and Natural Resource Operations

ENDORSEMENTS

Lease No: 103555 File No.: 1405218
Endorsement No.: 2 Date: July 17, 2013

Lease assigned unto Comox Valley Regional District by agreement dated January 18, 2012.

Authorized Representative

Appendix B
Borehole Logs

GRAPHICS, SYMBOLS AND ABBREVIATIONS ON LOGS

SAMPLE TYPES and TESTS

- SS Split Spoon Sample
- SN Non-Standard Split Spoon Sample
- ST Shelby Tube Sample : (unconfined compression or unconsolidated undrained test) - ◆
- DS Denision Type Sample
- PS Piston Type Sample
- CS Continuous Sample
- GS Grab Sample
- WS Wash Sample
- BQ BQ Core Sample
- HQ HQ Core Sample
- NQ NQ Core Sample
- DT Dynamic Penetration Test
- VT Field Vane Test (undisturbed) - +
- VT Field Vane Test (remoulded) - ⊕

PENETRATION RESISTANCES

Standard Penetration Resistance(N Value)

The number of blows by a 63.6 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split spoon sampler for a distance of 300 mm (12 in.).

ABBREVIATIONS

DTPL: Drier Than Plastic Limit
APL: About Plastic Limit
WTPL: Wetter Than Plasic Limit
K: Hydraulic Conductivity (m/s)
C_u: Undrained Shear Strength (kPa)
% REC : Percentage of Sample Recovered
% RQD : Indirect Measure of the Number of Fractures and Soundness of Rock Mass
▼ Approximate Water Table

GRAIN SIZE CLASSIFICATION

	%
trace, "eg. trace sand"	1 - 10
some, "eg. some sand"	10 - 20
adjective, "eg. sandy"	20 - 35
and, "eg. and sand"	35 - 50
noun, "eg. sand"	>50

Note: Classification Divisions Based on Modified M.I.T. Grain Size Scale

SOIL DESCRIPTIONS

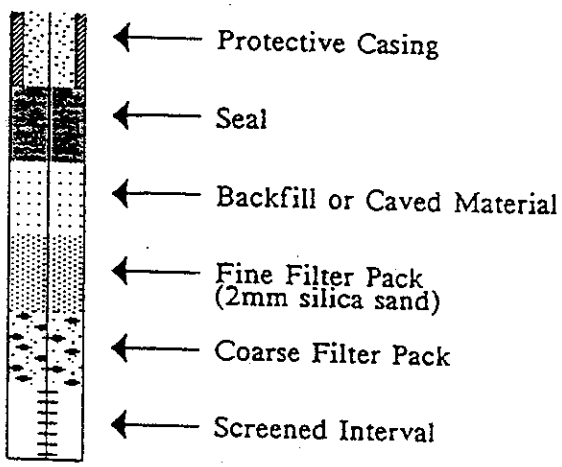
Cohesionless Soils

Relative Density	N Value
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

Cohesive Soils

Consistency	C_u(kPa)	N Value
Very soft	0 to 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	over 200	over 30

MONITOR DETAILS



BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 1 1 of 2

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

DATE: 11 January 1993
GEOLOGIST SRB
ELEVATION 154.0 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % REC	SAMPLE % RQD	N VALUE 15 30 45 60	WATER CONTENT (%) 10 20 30 40
1		SAND Medium brown fine to medium sand, trace silt, moist, loose.				GS						
2												
3												
4												
5												
6.1 6		SAND AND GRAVEL Medium brown fine to medium sand, trace silt, trace fine to medium subrounded gravel, moist, loose.				GS						
7												
8						GS						
9												
10												
11						GS						
12												
13.1 13		SAND Medium brown fine to medium sand, trace silt, trace fine to medium subrounded gravel, moist, compact.				GS						
14												
14.6 15		SAND AND GRAVEL Medium brown fine to medium sand, some fine to medium subrounded gravel, moist, compact.				GS						
16												
17		- Medium brown fine to medium sand and fine to coarse gravel with cobbles from 16.5 m to 17.1 m.				GS						
18						GS						
19												

BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 1 2 of 2

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

DATE: 11 January 1993
GEOLOGIST SRB
ELEVATION 154.0 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % REC	SAMPLE % RQD	N VALUE 15 30 45 60	WATER CONTENT (%) 10 20 30 40
21												
22												
23												
24												
24.8		Saturated at 24.80 m.										
25		SAND Medium brown fine to medium sand and fine to medium subrounded gravel, moist, compact.				GS						
26												
27												
28.0		Borehole sands cave from 28.00 m to 27.17 m.										
28		Borehole terminated at 28.00 m.										

BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 2 1 of 2

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

DATE: 12 January 1993
GEOLOGIST SRB
ELEVATION 165.9 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % REC	SAMPLE % RQD	N VALUE 15 30 45 60	WATER CONTENT (%) 10 20 30 40
1		**SAND AND GRAVEL** Medium brown fine to medium sand, trace silt and fine subrounded gravel, moist, loose.				GS						
5						GS						
12						GS						
15.2 15		**SAND** Medium brown fine to medium sand, trace silt, a few fine pieces of gravel, moist, loose.				GS						
18		- Gravel layer at 18.30 m to 18.50 m.										

Gartner Lee Limited

BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 2 2 of 2

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

DATE: 12 January 1993
GEOLOGIST SRB
ELEVATION 165.9 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % REC	SAMPLE % RQD	N VALUE 15 30 45 60	WATER CONTENT (%) 10 20 30 40
21												
22												
23												
24												
25												
26												
27		- Gravel layer at 27.40 m to 28.00 m.										
28												
29												
30.3 30												
		SAND AND SILT				GS						
31		Medium brown fine sand and silt, saturated, dense.										
32												
33												
34		Saturated at 33.75 m.										
35.3 35												
		Borehole terminated at 35.33 m below ground.										

BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 3 1 of 2

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

DATE: 14 January 1993
GEOLOGIST SRB
ELEVATION 153.6 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION
1.5		**SAND AND GRAVEL FILL** Grey fine to medium silty sand fill with some fine subrounded gravel, moist, loose.
		SAND AND GRAVEL Grey to dark brown fine to medium silty sand with refuse to 4.6 m, moist, loose.
6.1		**SAND** Dark brown fine to medium sand, some fine to medium gravel, trace silt, moist.
9.1		**SAND AND GRAVEL** Dark brown fine to medium sand and fine to coarse gravel, moist, dense.
12.2		
12.5		**SAND** Dark brown fine to medium sand, moist.
		SAND AND GRAVEL Alternating layers of medium brown, fine to medium sand and fine to coarse gravel and cobbles, moist, dense.

MONITOR DETAILS & NUMBER

SAMPLE: NUMBER | INTERVAL | TYPE | N VALUE | % WATER | % REC | % RQD

N VALUE (15 30 45 60)

WATER CONTENT (%) (10 20 30 40)

BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 3 2 of 2

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

DATE: 14 January 1993
GEOLOGIST SRB
ELEVATION 153.6 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION
21		
22		
23		
24		
25		
26		
27.0		Saturated below 26.40 m.
27		SAND Dark brown to grey fine to medium sand, trace silt, saturated, compact.
28		
29		
30		
31		
31.8		Borehole terminated at 31.80 m in sand. Stratigraphy logged from auger cuttings.

MONITOR DETAILS & NUMBER

SAMPLE: NUMBER | INTERVAL | TYPE | N VALUE | % WATER | % REC | % RQD

N VALUE: 15 30 45 60

WATER CONTENT (%): 10 20 30 40

BOREHOLE LOG

PROJECT: 92-746

BOREHOLE: 4 1 of 1

CAMPBELL RIVER SANITARY LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA
FOR: DISTRICT OF CAMPBELL RIVER

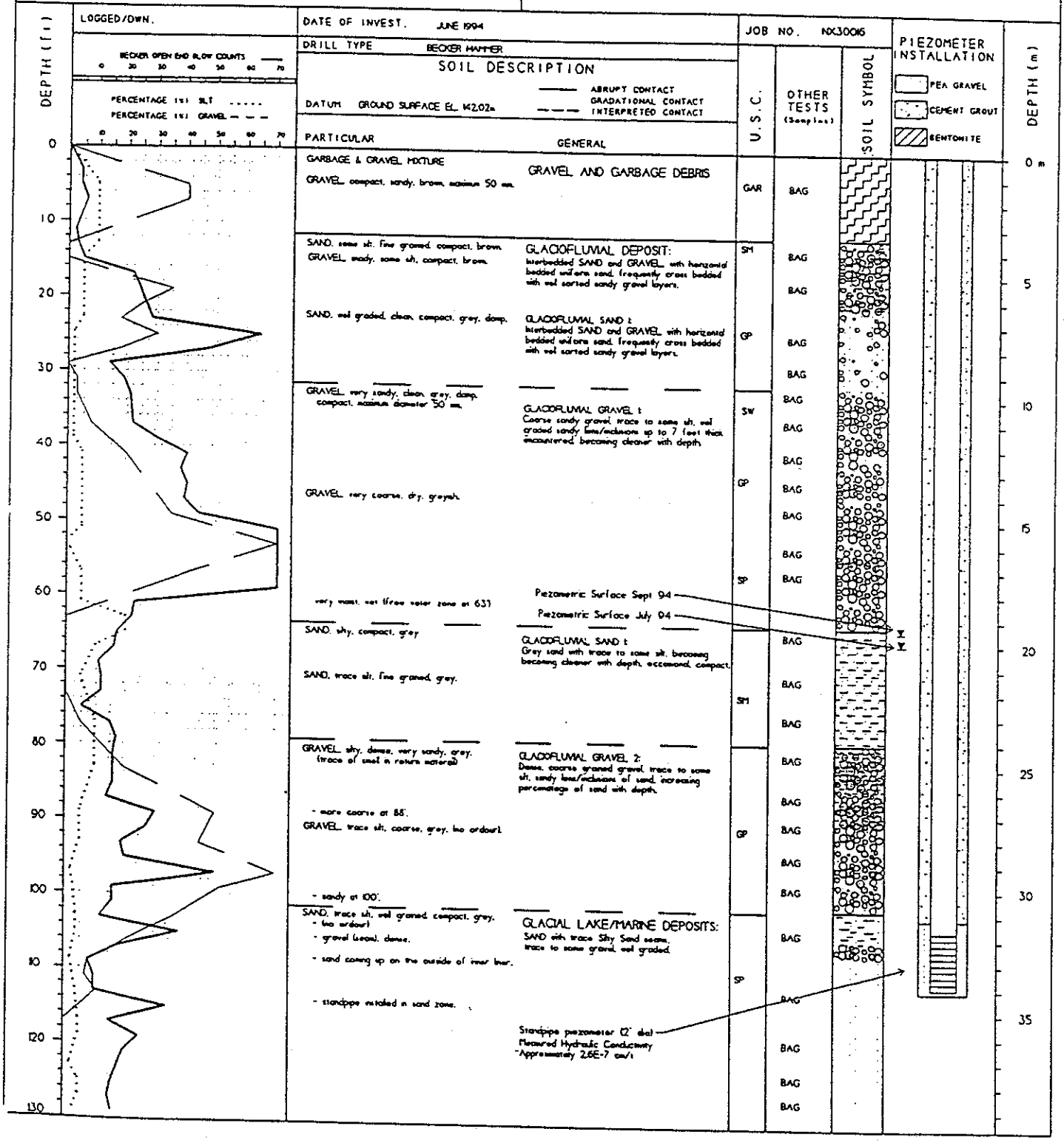
DATE: 14 January 1993
GEOLOGIST SRB
ELEVATION 146.4 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE % WATER	SAMPLE % REC	SAMPLE % RQD	N VALUE 15 30 45 60	WATER CONTENT (%) 10 20 30 40
0		**SAND**				GS						
1		Medium brown fine to medium sand, trace silt, moist, loose to compact.										
2												
3												
4												
5												
6												
7												
8												
9						GS						
10												
11												
12												
13						GS						
14												
15												
16												
17		Saturated at 17.1 m.										
18		Changes to grey in colour below 17.5 m.				GS						
19.4	19											
		Borehole terminated at 19.4 m in sand.										

AGRA
Earth & Environmental

LOG OF BOREHOLE NO. HBT 94-1

DISTRICT OF CAMPBELL RIVER LANDFILL. ARGONAUT ROAD
1994 HYDROGEOLOGIC INVESTIGATIONS



AGRA
Earth & Environmental

LOG OF BOREHOLE NO HBT 94-2

DISTRICT OF CAMPBELL RIVER LANDFILL, ARGONAUT ROAD
1994 HYDROGEOLOGIC INVESTIGATIONS

LOGGED/DWN.

DATE OF INVEST. JUNE 1994

JOB NO. NX30015

DRILL TYPE BECKER HAMMER

BECKER OPEN END BLOW COUNTS (0 10 20 30 40 50 60 70)

PERCENTAGE (%) SILT

PERCENTAGE (%) GRAVEL

SOIL DESCRIPTION

DATUM GROUND SURFACE EL. 145.55m

ABRUPT CONTACT
GRADATIONAL CONTACT
INTERPRETED CONTACT

DEPTH (ft)	PARTICULAR	GENERAL	U.S.C.	OTHER TESTS (Samples)	SOIL SYMBOL	DEPTH (m)
0	GRAVEL & GARBAGE DEBRIS - (strong odour) - (soft fill) - shoes - rubber debris	GRAVEL AND GARBAGE DEBRIS		BAG BAG BAG		0 m
20	SAND, wel grained, trace sh. brown, moist.	GLACIOFLUVIAL DEPOSIT: Interbedded SAND and GRAVEL, with horizontal bedded uniform sand, frequently cross bedded with well sorted sandy gravel layers.	SM	BAG		5
30		GLACIOFLUVIAL SAND I Fine grained, dense to compact sand, trace to some sh, interbedded with seams / layers of gravel / sh.	SM	BAG		10
40	- more coarse at 38'. GRAVEL, some sh, moist, very sandy, brown.	GLACIOFLUVIAL GRAVEL I Coarse sandy gravel trace to some sh, wel grained sandy lens/inclusions up to 7 feet thick encountered.	GP	BAG		15
50	- grey at 40' - very coarse gravel sand. - more moist.			BAG BAG		
60	SAND, some sh, coarse grained, moist, compact, grey - water table at 62'	GLACIOFLUVIAL SAND I trace to some sh, becoming cleaner with depth, occasional lens of gravel/pebbles, compact to dense.	SP	BAG		20
70	SAND, wel grained, grey, compact, moist, occasional pebble upto 20 mm dia.			BAG BAG		
80	GRAVEL, poorly graded, some sh, dense, brownish, max. 50 mm in dia.	GLACIOFLUVIAL GRAVEL 2: Interbedded/layers of dense coarse gravel/sh with trace to some sand, increasing percentage of sand with depth.	GP	BAG BAG		25
90	- dense gravel			BAG		
100	SAND, some sh, compact to dense, fine grained, greyish, some #4.	GLACIAL LAKE/MARINE DEPOSITS: SAND with trace Silty Sand seams, becoming more fine grained with depth.	SP	BAG BAG		30
110				BAG		
120	- saturated			BAG BAG		35
130				BAG		
140	End of Hole 145'					40

Piezometric surface Sept 94

Piezometric Surface Aug 94

Standpipe piezometer (2" dia)
Measured Hydraulic Conductivity
Approximately 2.5E-6 cm/s

PIEZOMETER INSTALLATION
PEA GRAVEL
CEMENT GROUT
BENTONITE

AGRA
Earth & Environmental

LOG OF BOREHOLE NO. HBT 94-3

DISTRICT OF CAMPBELL RIVER LANDFILL. ARGONAUT ROAD
1994 HYDROGEOLOGIC INVESTIGATIONS

LOGGED/DWN.

DATE OF INVEST. JUNE 1994

DRILL TYPE BECKER HAMMER

DATUM GROUND SURFACE EL. 142.02m

JOB NO. NX30016

BECKER OPEN END BLOW COUNTS

PERCENTAGE (%) SILT

PERCENTAGE (%) GRAVEL

DEPTH (ft)

SOIL DESCRIPTION

ABRUPT CONTACT
GRADATIONAL CONTACT
INTERPRETED CONTACT

PARTICULAR	GENERAL	U.S.C.	OTHER TESTS (Samples)	SOIL SYMBOL
GRAVEL & GARBAGE DEBRIS (Fill)	GRAVEL & GARBAGE DEBRIS (Fill)			
SAND, fine grained, compact to dense, some silt, brown.	GLACIOFLUVIAL DEPOSIT: interbedded SAND and GRAVEL with horizontal bedded uniform sand, frequently cross bedded with well sorted sandy gravel layers.	SM		
SAND, poorly graded, compact to dense, brown.	GLACIOFLUVIAL SAND 1: Fine grained, dense to compact sand, trace to some silt, interbedded with seams / layers of gravel / silt.	SP	BAG	
GRAVEL, sandy, compact to dense, brown.	GLACIOFLUVIAL GRAVEL 1: Coarse sandy gravel, trace to some silt, poorly graded sandy lens/inclusions up to 10 feet thick encountered, becoming cleaner with depth.			
- trace silt, grash at 47'.				
- coarse sand and gravel at 50'.		GP		
	Piezometric Surface Sept 94			
	Piezometric Surface Aug 94		BAG	
SAND, some silt, well grained, compact to dense, clean.	GLACIOFLUVIAL SAND 2: Grey sand with trace to some silt, becoming cleaner with depth, well grained compact to dense.	SP	BAG BAG BAG	
SAND, fine grained, grey, compact.				
- loss of water at 73'.			BAG	
	Standpipe piezometer (2" dia) Measured Hydraulic Conductivity Approximately $1.3E-2$ cm/s			
GRAVEL, clean, coarse, dense, grey.	GLACIOFLUVIAL GRAVEL 2: Dense, coarse grained gravel producing substantial volumes of water.	GP	BAG	
End of Hole 88'				

PIEZOMETER INSTALLATION
PEA GRAVEL
CEMENT GROUT
BENTONITE

DEPTH (m)

AGRA
Earth & Environmental

LOG OF BOREHOLE NO. HBT 94-4

DISTRICT OF CAMPBELL RIVER LANDFILL. ARGONAUT ROAD
1994 HYDROGEOLOGIC INVESTIGATIONS

LOGGED/DWN.

DATE OF INVEST. JUNE 1994

DRILL TYPE BECKER HAMMER

JOB NO. NX30016

DATUM GROUND SURFACE EL. 139.9m

BECKER OPEN END BLOW COUNTS
0 10 20 30 40 50 60 70

PERCENTAGE (%) SLT .....
PERCENTAGE (%) GRAVEL — — —
0 10 20 30 40 50 60 70

DEPTH (ft)

SOIL DESCRIPTION

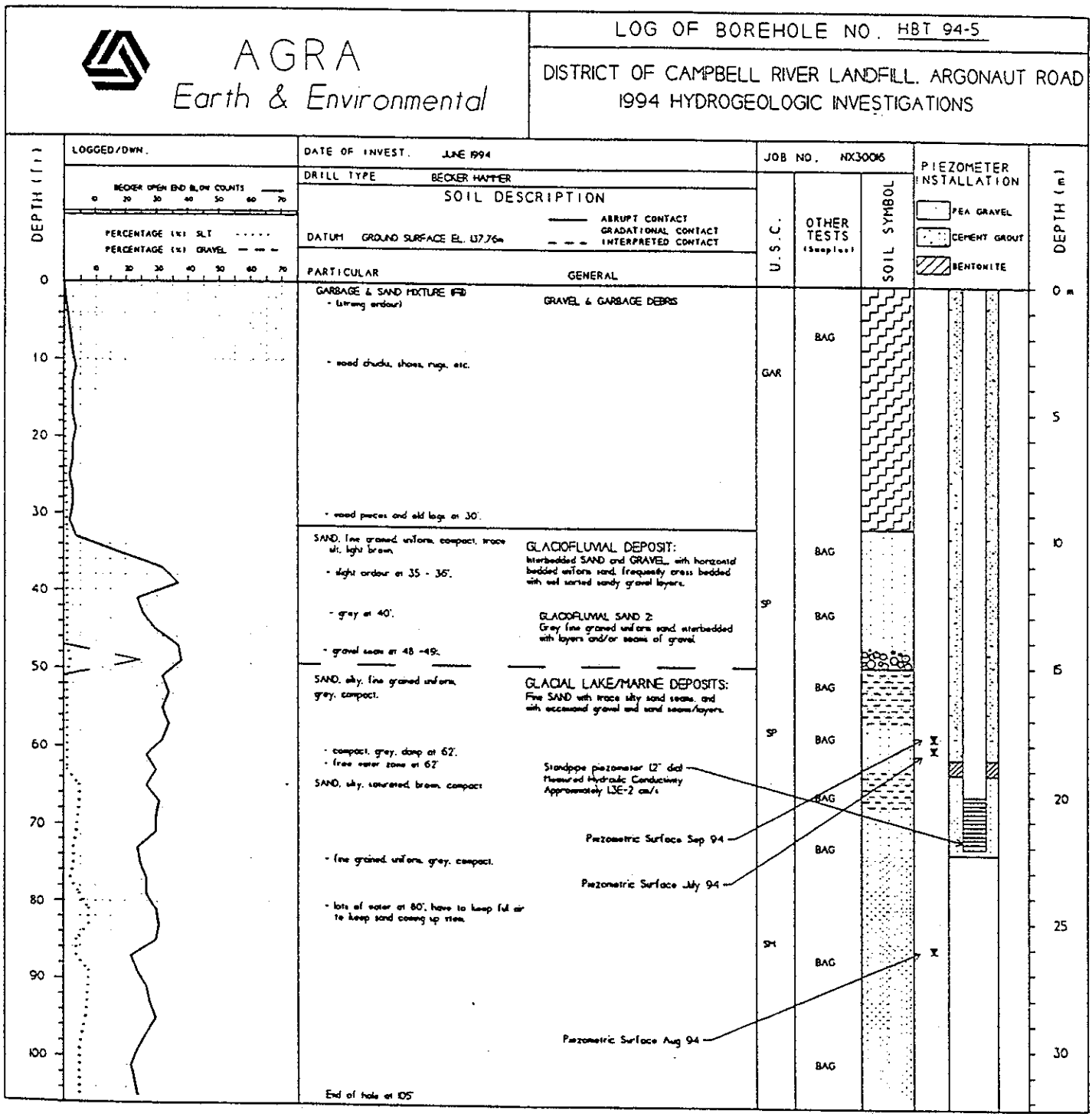
ABRUPT CONTACT
GRADATIONAL CONTACT
INTERPRETED CONTACT

PARTICULAR	GENERAL	U.S.C.	OTHER TESTS (Samples)	SOIL SYMBOL
GRAVEL & GARBAGE (FILL) - (strong odour)	GRAVEL & GARBAGE DEBRIS		BAG	
SAND, well grained, compact, rusty brown. - gas refused at 6'				
GRAVEL, very sandy, clean, greyish, compact to dense.		SM GP	BAG	
SAND, poorly graded, compact, grey.	GLACIOFLUVIAL DEPOSIT: Interbedded SAND and GRAVEL with horizontal bedded and ripple sand, frequently cross bedded with well sorted sandy gravel layers.		BAG	
- dense layer at 25'			BAG	
- clean, fine grained, light grey at 35'.	GLACIOFLUVIAL SAND I: Grey fine grained sand, interbedded with layers and/or inclusions of silt, dense to compact.		BAG	
		SP	BAG	
Piezometric Surface Aug 94				
- silt layer at 54 - 56.5', light brown.			BAG	
SAND, very silty, moist, greyish.		SM	BAG	
Piezometric Surface July 94			BAG	
- water table at 62'				
GRAVEL, clean, some silt, some sand, dense, grey.	GLACIOFLUVIAL GRAVEL 2: Dense, coarse grained gravel, trace to some silt and sand, becoming cleaner and sandier with depth.		BAG	
- silty gravel at 77'			BAG	
			BAG	
		GP		
			BAG	
			BAG	
Standpipe piezometer (2" dia) Measured Hydraulic Conductivity Approximately 1.3E-2 cm/s				
- sandier at 109'.			BAG	
End of Hole 120'			BAG	

PIEZOMETER INSTALLATION
PEA GRAVEL
CEMENT GROUT
BENTONITE

DEPTH (m)

0 10 20 30 40 50 60 70 80 90 100 110 120
0 m 5 10 15 20 25 30 35


AGRA
Earth & Environmental
LOG OF BOREHOLE NO. HBT 94-5
DISTRICT OF CAMPBELL RIVER LANDFILL. ARGONAUT ROAD
1994 HYDROGEOLOGIC INVESTIGATIONS
LOGGED/DWN.
DATE OF INVEST. JUNE 1994
DRILL TYPE BECKER HAMMER
DATUM GROUND SURFACE EL. 137.76m
JOB NO. NX30016
SOIL DESCRIPTION
ABRUPT CONTACT
GRADATIONAL CONTACT
INTERPRETED CONTACT
BECKER OPEN END BLOW COUNTS
PERCENTAGE (%) SLT
PERCENTAGE (%) GRAVEL
PARTICULAR
GENERAL
U.S.C.
OTHER TESTS (Sample)
SOIL SYMBOL
PIEZOMETER INSTALLATION
PEA GRAVEL
CEMENT GROUT
BENTONITE
DEPTH (ft)
DEPTH (m)
GARBAGE & SAND MIXTURE (FILL)
- strong ordour
GRAVEL & GARBAGE DEBRIS
- wood chucks, shoes, rugs, etc.
- wood pieces and old logs at 30'.
SAND, fine grained, uniform, compact, trace silt, light brown.
- slight ordour at 35 - 36'.
- grey at 40'.
- gravel seam at 48 -49'.
GLACIOFLUVIAL DEPOSIT:
Interbedded SAND and GRAVEL, with horizontal bedded uniform sand, frequently cross bedded with well sorted sandy gravel layers.
GLACIOFLUVIAL SAND 2:
Grey fine grained uniform sand, interbedded with layers and/or seams of gravel.
SAND, silty, fine grained uniform, grey, compact.
- compact, grey, damp at 62'.
- free water zone at 62'
SAND, silty, saturated, brown, compact
GLACIAL LAKE/MARINE DEPOSITS:
Fine SAND with trace silty sand seams, and with occasional gravel and sand seams/layers.
- fine grained, uniform, grey, compact.
- lots of water at 80', have to keep full air to keep sand coming up stem.
Standpipe piezometer 12" dia.
Measured Hydraulic Conductivity
Approximately 1.3E-2 cm/s
Piezometric Surface Sep 94
Piezometric Surface July 94
Piezometric Surface Aug 94
GAR
SP
SP
SM
BAG
BAG
BAG
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BAG
BAG
End of hole at 105'
DEPTH (ft)
0
10
20
30
40
50
60
70
80
90
100
DEPTH (m)
0 m
5
10
15
20
25
30

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-01
ADDITIONAL MONITORING WELL INSTALLATIC	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) GRAB (WATER)

BACKFILL TYPE: BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND FILTER PK

Depth(m)	USC	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments
0.0	OL	SAND – medium grained, poorly sorted, moderately oxidized, trace gravel/cobbles up to 100 mm diameter.			
3.0	SP/GP	SAND AND GRAVEL – trace silt, poorly graded, damp.		01	
6.0	SP	SAND – some gravel, trace silt, poorly graded, damp.		02	
9.0	SP/GP	GRAVEL AND SAND – trace silt, poorly graded, damp.		03	
12.0	SP	SAND – trace silt, fine grained, damp.		04	
18.0	ML	SILT – some clay, some fine sand, laminated.		05	
21.0	SP	SAND – trace silt, fine grained, wet.		06	Cuttings are wet below 23.2 m.
24.0				07	
27.0		SAND – some gravel, trace silt.		08	
30.0					

% Fines 20 40 60 80

% Sand 20 40 60 80

% Gravel 20 40 60 80

SLOTTED PIEZOMETER

Depth(ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85, 90, 95

AGRA Earth & Environmental
Nanaimo, B.C.

LOGGED BY: JW
REVIEWED BY: JR

COMPLETION DEPTH: 48.5 m
COMPLETE: 17/06/99

00/03/23 04:01Pm (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-01
ADDITIONAL MONITORING WELL INSTALLATIO	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments
30.0	SP				
31.0		SAND AND SILT – low plastic, wet.		09	
32.0	SM/ML				
33.0					
34.0		SAND – some silt, fine grained, wet.		11	
35.0	SM				
36.0					
37.0		SAND – trace silt, fine grained, wet.		12	
38.0					
39.0					
40.0				13	
41.0	SP				
42.0					
43.0					
44.0					
45.0					
46.0		GRAVEL – little sand, clean, wet, occasional cobbles/cobble fragments up to 120 mm diameter.		14	
47.0	GP				
48.0					
49.0		End of Hole at 48.5 m.			
50.0					
51.0					
52.0					
53.0					
54.0					
55.0					
56.0					
57.0					
58.0					
59.0					
60.0					

■ % Fines ■ 20 40 60 80

◆ % Sand ◆ 20 40 60 80

● % Gravel ● 20 40 60 80

SLOTTED PIEZOMETER

Depth(ft): 100. 105. 110. 115. 120. 125. 130. 135. 140. 145. 150. 155. 160. 165. 170. 175. 180. 185. 190. 195.

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LOGGED BY: JW
REVIEWED BY: JR

COMPLETION DEPTH: 48.5 m
COMPLETE: 17/06/99

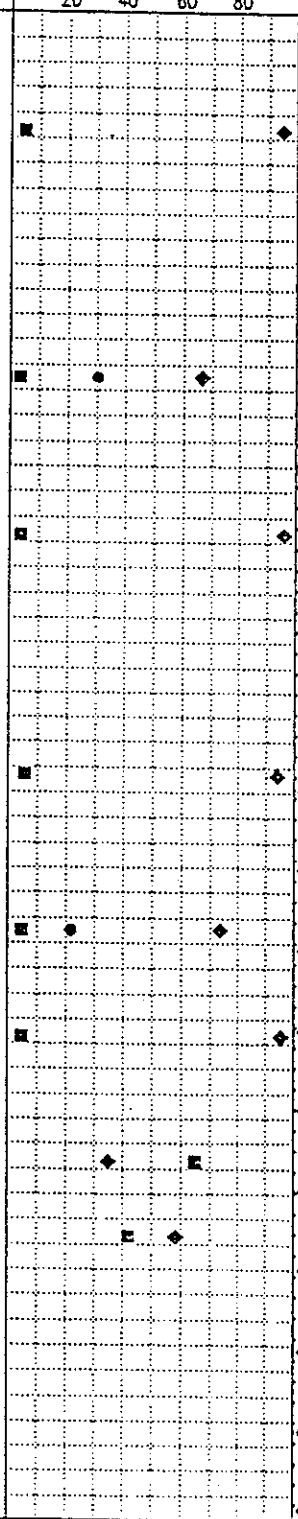
00/03/23 04:01Pm (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-02
ADDITIONAL MONITORING WELL INSTALLATIO	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments
0.0			SAND – silty, cobbles, oxidized, sand is fine grained.			
3.0	SP		SAND – trace silt, fine grained, occasional gravel, damp, poorly graded.		01	
7.0			SAND – some gravel, trace silt, max 100 mm diameter, damp, poorly graded.		02	
10.0			SAND – fine grained, trace silt, damp, poorly graded.		03	
13.0	SP/ML		– silt lenses from 13.7 to 14.9 m.			
15.0			SAND – some gravel, trace silt, damp, poorly graded.		04	
18.0	SP				05	
20.0			SAND – fine to medium grained, trace silt, wet.		06	
23.0	ML		SILT – some fine sand, low plastic, moist, oxidized.		07	
24.0			SAND AND SILT – low plastic, moist.		08	
27.0	ML/SP					Water encountered at 27.7 m depth.
30.0						



SLOTTED PIEZOMETER

Depth(ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0

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LOGGED BY: JW	COMPLETION DEPTH: 51.51 m
REVIEWED BY: JR	COMPLETE: 18/06/99

00/03/23 04:01PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-02
ADDITIONAL MONITORING WELL INSTALLATIO.	Method: Becker Hammer	PROJECT NO: NX201360
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	% Fines / % Sand / % Gravel (20 40 60 80)	SLOTTED PIEZOMETER	Depth(ft)
30.0			SAND – little silt, poorly graded, wet.		09				100.
31.0	SW								
32.0									
33.0			SAND – trace silt, fine grained, wet.		10				110.
34.0									
35.0									115.
36.0									
37.0					11	Rapid drill penetration.			120.
38.0									
39.0									125.
40.0									
41.0	SP								135.
42.0									
43.0					12				140.
44.0									
45.0									145.
46.0					13				150.
47.0									
48.0									155.
49.0					14				160.
50.0	GW		GRAVEL – some sand, some cobbles, clean.						165.
51.0									
52.0			End of Hole at 51.5 m. Well installed.						170.
53.0									
54.0									175.
55.0									180.
56.0									
57.0									185.
58.0									190.
59.0									
60.0									195.

AGRA Earth & Environmental
Nanaimo, B.C.

LOGGED BY: JW | COMPLETION DEPTH: 51.51 m
REVIEWED BY: JR | COMPLETE: 18/06/99

00/03/23 04:01PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-03
ADDITIONAL MONITORING WELL INSTALLATIC	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	% Fines / % Sand / % Gravel (20 40 60 80)	SLOTTED PIEZOMETER	Depth(ft)
0.0		SAND – some silt, fine to medium grained sand, oxidized.						0.0
1.0								5.0
2.0	SM	SAND – some silt, fine grained, damp, grey.						
3.0				01				10.0
4.0								
5.0	SM/ML	SAND – some silt, fine grained sand, interbedded silt layers up to 40 mm thick, damp, grey.						15.0
6.0		SAND AND SILT – brow-grey, damp.						20.0
7.0								25.0
8.0	SM			02				
9.0								30.0
10.0								
11.0		GRAVEL – some sand, trace silt, damp, subrounded to subangular, max diameter 150 mm, poorly graded.						35.0
12.0	GP			03				40.0
13.0								
14.0		GRAVEL AND SAND – trace silt, cobbles up to 120 mm diameter recovered, poorly graded.		04	Fast penetration with drill.			45.0
15.0								50.0
16.0		SAND AND GRAVEL – trace silt, well rounded, well graded, damp. Coarsening at depth.		05	Wet at 16.8 m bgs.			
17.0								55.0
18.0	GW							60.0
19.0								
20.0		GRAVEL – some coarse sand, wet, well graded.		06				65.0
21.0		GRAVEL AND SAND – poorly graded, cobbles up to 150 mm diameter recovered.			Drill penetration rate slower.			70.0
22.0				07				
23.0								75.0
24.0								80.0
25.0	GP	– poor sample recovery. Recovered material is cobble sized.						
26.0								85.0
27.0		GRAVEL AND SAND – coarse grained sand, cobbles up to 100 mm diameter recovered, poorly graded.						90.0
28.0				08				
29.0								95.0
30.0								

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LOGGED BY: JR | COMPLETION DEPTH: 53.2 m
REVIEWED BY: JW | COMPLETE: 18/06/99

00/03/23 04:01PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-03
ADDITIONAL MONITORING WELL INSTALLATIO	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) GRAB (WATER)

BACKFILL TYPE: BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	% Fines / % Sand / % Gravel (20 40 60 80)	SLOTTED PIEZOMETER	Depth(ft)
30.0	GP		– well graded.		09				100.0
31.0									
32.0									105.0
33.0									
34.0									110.0
35.0	GW								115.0
36.0					10				
37.0									120.0
38.0									
39.0									125.0
40.0			– poorly graded.		12				130.0
41.0									
42.0									135.0
43.0			GRAVEL – some cobbles, little sand, poorly graded.		13				140.0
44.0	GP								
45.0									145.0
46.0			– increasing sand content.		14				150.0
47.0									
48.0									155.0
49.0			GRAVEL – some sand, well graded.		15				160.0
50.0									
51.0	GW								165.0
52.0									170.0
53.0									
54.0			End of Hole at 53.2 m.			Drill penetration rate very slow. Drill bit blocked, withdraw to 50.6 m.			175.0
55.0									180.0
56.0									
57.0									185.0
58.0									190.0
59.0									
60.0									195.0

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LOGGED BY: JR	COMPLETION DEPTH: 53.2 m
REVIEWED BY: JW	COMPLETE: 18/06/99

00/03/23 04:01PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-04
ADDITIONAL MONITORING WELL INSTALLATIO.	Method: Becker Hammer	PROJECT NO: NX2013694
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	% Fines / % Sand / % Gravel (20 40 60 80)	SLOTTED PIEZOMETER	Depth(ft)
0.0	SM		SAND – silty, fine grained, oxidized, trace gravel, damp.						0.0
3.0	SW		SAND – little gravel, trace silt, well graded, damp.						10.0
6.0	SP		SAND – some gravel, trace silt, poorly graded, damp.		01				20.0
9.0	SP/GP		SAND AND GRAVEL – trace silt, poorly graded, damp.		02				30.0
12.0	GW		GRAVEL – some sand, trace silt, well graded, damp.		03				40.0
18.0	SP		SAND – little gravel, wet, poorly graded.		04				60.0
21.0	GP		GRAVEL AND SAND – medium to coarse sand, poorly graded, wet.		05				70.0
24.0	SP		SAND AND GRAVEL – poorly graded, wet.		06	Water encountered at 19.2 m.			80.0
27.0	GP		GRAVEL – some sand, poorly graded, wet.		07				90.0
30.0					08				100.0
					09				

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LOGGED BY: JW
REVIEWED BY: JR

COMPLETION DEPTH: 45.42 m
COMPLETE: 17/06/99

00/03/23 04:01PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-04
ADDITIONAL MONITORING WELL INSTALLATION	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) GRAB (WATER)

BACKFILL TYPE: BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	% Fines / % Sand / % Gravel (20 40 60 80)	SLOTTED PIEZOMETER	Depth(ft)
30.0									100.0
31.0									
32.0					10				105.0
33.0	GP								
34.0					11				110.0
35.0									
36.0									115.0
37.0			GRAVEL – little sand, well graded, wet.						
38.0	GW				12				120.0
39.0									125.0
40.0			GRAVEL – some sand, poorly graded, wet.						
41.0					13				130.0
42.0	GP								135.0
43.0			GRAVEL – some cobbles, trace sand, poorly graded.		14				140.0
44.0									
45.0									145.0
46.0			End of Hole at 45.4 m. Slow drilling. Well installed.						150.0
47.0									
48.0									155.0
49.0									160.0
50.0									
51.0									165.0
52.0									170.0
53.0									
54.0									175.0
55.0									180.0
56.0									
57.0									185.0
58.0									190.0
59.0									
60.0									195.0

AGRA Earth & Environmental
Nanaimo, B.C.

LOGGED BY: JW
REVIEWED BY: JR

COMPLETION DEPTH: 45.42 m
COMPLETE: 17/06/99

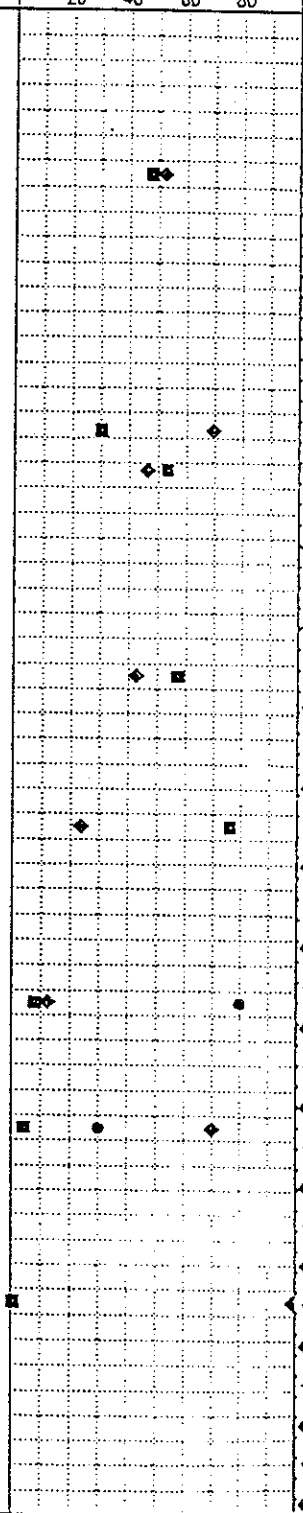
00/03/23 04:01PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-05
ADDITIONAL MONITORING WELL INSTALLATIO...	Method: Becker Hammer	PROJECT NO: NX201.3604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments
0.0						
1.0	OL		Oxidized loam.			
2.0			SAND AND SILT – fine grained, low plastic.			
3.0					01	
4.0						
5.0	ML					
6.0						
7.0						
8.0	SM		SAND – some silt, fine sand, moderately oxidized, damp.		02	
9.0			SILT AND SAND – fine sand, silt layers approx. 10 to 20 mm thick.		03	
10.0						
11.0						
12.0			SILT AND SAND – fine sand, little clay, low plastic, wet, fragments show bedding and laminations.			
13.0					04	
14.0	ML					
15.0			SILT – some clay, some fine sand, low plastic, moist to wet.			
16.0					05	
17.0						
18.0						
19.0						
20.0	GP		GRAVEL – little sand, trace silt, wet, poorly graded.		06	
21.0			SAND – some gravel, trace silt, poorly graded, wet.			
22.0						
23.0					07	
24.0						
25.0						
26.0	SP		SAND – trace silt, medium to fine grained, poorly graded, wet.		08	
27.0						
28.0						
29.0						
30.0						



SLOTTED PIEZOMETER

Depth(ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0

AGRA Earth & Environmental
Nanaimo, B.C.

LOGGED BY: JW	COMPLETION DEPTH: 50.9 m
REVIEWED BY: JR	COMPLETE: 18/06/99

00/03/23 04:02PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-05
ADDITIONAL MONITORING WELL INSTALLATIO	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	% Fines / % Sand / % Gravel (20 40 60 80)	SLOTTED PIEZOMETER	Depth(ft)
30.0									100.0
31.0	SP								
32.0									105.0
33.0			SAND AND GRAVEL – poorly graded, cobbles up to 120 mm diameter.		09	Fast drill penetration.			
34.0	GP/SP				10	Low recovery, slow penetration rate.			110.0
35.0									115.0
36.0									
37.0			GRAVEL – some sand, poorly graded, occasional cobbles up to 120 mm diameter.						120.0
38.0	GP								125.0
39.0									
40.0									130.0
41.0			SAND – some gravel, poorly graded, wet.		11				135.0
42.0									
43.0									140.0
44.0									
45.0									145.0
46.0	SP		SAND – little gravel, trace silt, medium to fine grained.		12				150.0
47.0									
48.0									155.0
49.0									
50.0									160.0
51.0			End of Hole at 50.9 m.						165.0
52.0									170.0
53.0									
54.0									175.0
55.0									180.0
56.0									
57.0									185.0
58.0									190.0
59.0									
60.0									195.0

AGRA Earth & Environmental
Nanaimo, B.C.

LOGGED BY: JW | COMPLETION DEPTH: 50.9 m
REVIEWED BY: JR | COMPLETE: 18/06/99

00/03/23 04:02Pm (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA

ADDITIONAL MONITORING WELL INSTALLATION

Drilling Contractor: BECK Drilling

Method: Becker Hammer

BOREHOLE NO: AG99-06

PROJECT NO: NX2013604

ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER)

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments
0.0			SAND – medium grained.			
13.0			– grades to fine sand.			
17.0			SAND – some gravel, little silt, moist, medium grained sand.			
19.0			SAND – little silt, fine grained sand.		01	
25.0			SILT – sandy, fine grained, wet.		02	
30.0					03	

■ % Fines ■ 20 40 60 80

◆ % Sand ◆ 20 40 60 80

● % Gravel ● 20 40 60 80

SLOTTED PIEZOMETER

Depth(ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0

AGRA Earth & Environmental

Nanaimo, B.C.

LOGGED BY: JW

REVIEWED BY: JR

COMPLETION DEPTH: 45.11 m

COMPLETE: 18/06/99

00/00/23 04:00PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Drilling Contractor: BECK Drilling	BOREHOLE NO: AG99-06
ADDITIONAL MONITORING WELL INSTALLATIO..	Method: Becker Hammer	PROJECT NO: NX2013604
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) GRAB (WATER)

BACKFILL TYPE: BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND FILTER PK

Depth(m)	USC	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments
30.0			– interbedded fine SAND and SILT layers, very wet.		03	
31.0						
32.0			SILT – some sand, some clay, low plastic, soft.		04	
33.0			SILT – some fine sand, some clay, wet.		05	
34.0						
35.0						
36.0						
37.0						
38.0						
39.0			SILT AND SAND – fine sand, wet, occasional silt lense approx. 0.3 m thick slows drill penetration rate.			
40.0						
41.0						
42.0			– low recovery, silty fine SANDS.			
43.0						
44.0						
45.0			End of Hole at 45.1 m. Hole sloughed in to 39.3 m, attempt to redrill, rods blocked. Grout from 39.3 m to 25 m. Install well.			
46.0						
47.0						
48.0						
49.0						
50.0						
51.0						
52.0						
53.0						
54.0						
55.0						
56.0						
57.0						
58.0						
59.0						
60.0						

% Fines: 20 40 60 80

% Sand: 20 40 60 80

% Gravel: 20 40 60 80

SLOTTED PIEZOMETER

Depth(ft): 100.0 105.0 110.0 115.0 120.0 125.0 130.0 135.0 140.0 145.0 150.0 155.0 160.0 165.0 170.0 175.0 180.0 185.0 190.0 195.0

AGRA Earth & Environmental
Nanaimo, B.C.

LOGGED BY: JW	COMPLETION DEPTH: 45.11 m
REVIEWED BY: JR	COMPLETE: 18/06/99

00/03/23 04:00PM (BOREHOLE)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Contractor: BECK Drilling	BOREHOLE NO: AM00-01
ADDITIONAL MONITORING WELL INSTALLATIC	Method: Becker Hammer, Hollow Stem	PROJECT NO: NX2025502-600
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER) | SPT

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	Becker Hammer Blow Count (100 200 300 400)	SLOTTED PIEZOMETER	Depth(ft)
0.0		GARBAGE – plastic, wood, rags, etc.						0.0
1.0								5.0
2.0								10.0
3.0								15.0
4.0								20.0
5.0								25.0
6.0								30.0
7.0								35.0
8.0								40.0
9.0								45.0
10.0		Black sludge with sewage odour noted from 9.5 m to 10.7 m bgs.						50.0
11.0								55.0
12.0								
13.0								
14.0								
15.0								
16.0								
17.0								
18.0								

AMEC Earth & Environmental Limited
Nanaimo, B.C.

LOGGED BY: BH | COMPLETION DEPTH: 48.463 m
REVIEWED BY: CM | COMPLETE: 21/09/00

00/09/27 1E:12AM (NX2025S)

REGIONAL DISTRICT OF COMOX-STRATHCONA	Contractor: BECK Drilling	BOREHOLE NO: AM00-01
ADDITIONAL MONITORING WELL INSTALLATIO	Method: Becker Hammer, Hollow Stem	PROJECT NO: NX2025502-600
		ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER) | SPT

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	Soil Description	Additional Comments
26.0	Wood debris.	Dust appearing in cyclone.
	GRAVEL – some sand, very dense, greyish.	
29.0	–becoming damp at 29.3 m.	
33.0	SAND – clean, very dense, moist, grey.	
34.0	GRAVEL – sandy, clean, very dense, moist.	

SAMPLE TYPE / RUN NO: G1, G2, G3

Becker Hammer Blow Count: 100, 200, 300, 400

SLOTTED PIEZOMETER

Depth(ft): 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0, 100.0, 105.0, 110.0, 115.0

AMEC Earth & Environmental Limited
Nanaimo, B.C.

LOGGED BY: BH	COMPLETION DEPTH: 48.463 m
REVIEWED BY: CM	COMPLETE: 21/09/00

00/09/27 11:12AM (NX2025S5)

REGIONAL DISTRICT OF COMOX-STRATHCONA
ADDITIONAL MONITORING WELL INSTALLATIO

Contractor: BECK Drilling
Method: Becker Hammer, Hollow Stem

BOREHOLE NO: AM00-01
PROJECT NO: TV2025503-500
ELEVATION:

SAMPLE TYPE: GRAB (SOIL) | GRAB (WATER) | SPT

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND FILTER PK

Depth(m)	SOIL SYMBOL	Soil Description	SAMPLE TYPE	RUN NO	Additional Comments	Becker Hammer Blow Count (100 200 300 400)	SLOTTED PIEZOMETER	Depth(ft)
36.0		SAND – clean, very dense, uniform, grey.						120.0
37.0		GRAVEL – some sand, very dense, grey.			Boulder encountered at 36.9 m bgs.			125.0
38.0				G4				
39.0		–becoming wet at 39.3 m.						130.0
40.0								
41.0								135.0
42.0								
43.0								140.0
44.0				G5				
45.0								145.0
46.0								150.0
47.0								
48.0								155.0
49.0		End of Hole at 48.5 m. Monitoring well installed. Screen from 33.2 m to 48.5 m bgs. Sand from 0 to 30.8 m bgs. Bentonite plug from 30.8 m to 32.3 m bgs. Sand from 32.3 m to 48.5 m bgs.						160.0
50.0								
51.0								165.0
52.0		Borehole located 20 m NW of 1st attempt. 2nd attempt located 10 m S of 1st attempt.						170.0
53.0								
54.0								175.0

AMEC Earth & Environmental Limited
Nanaimo, B.C.

LOGGED BY: BH
REVIEWED BY: CM

COMPLETION DEPTH: 48.463 m
COMPLETE: 21/09/00

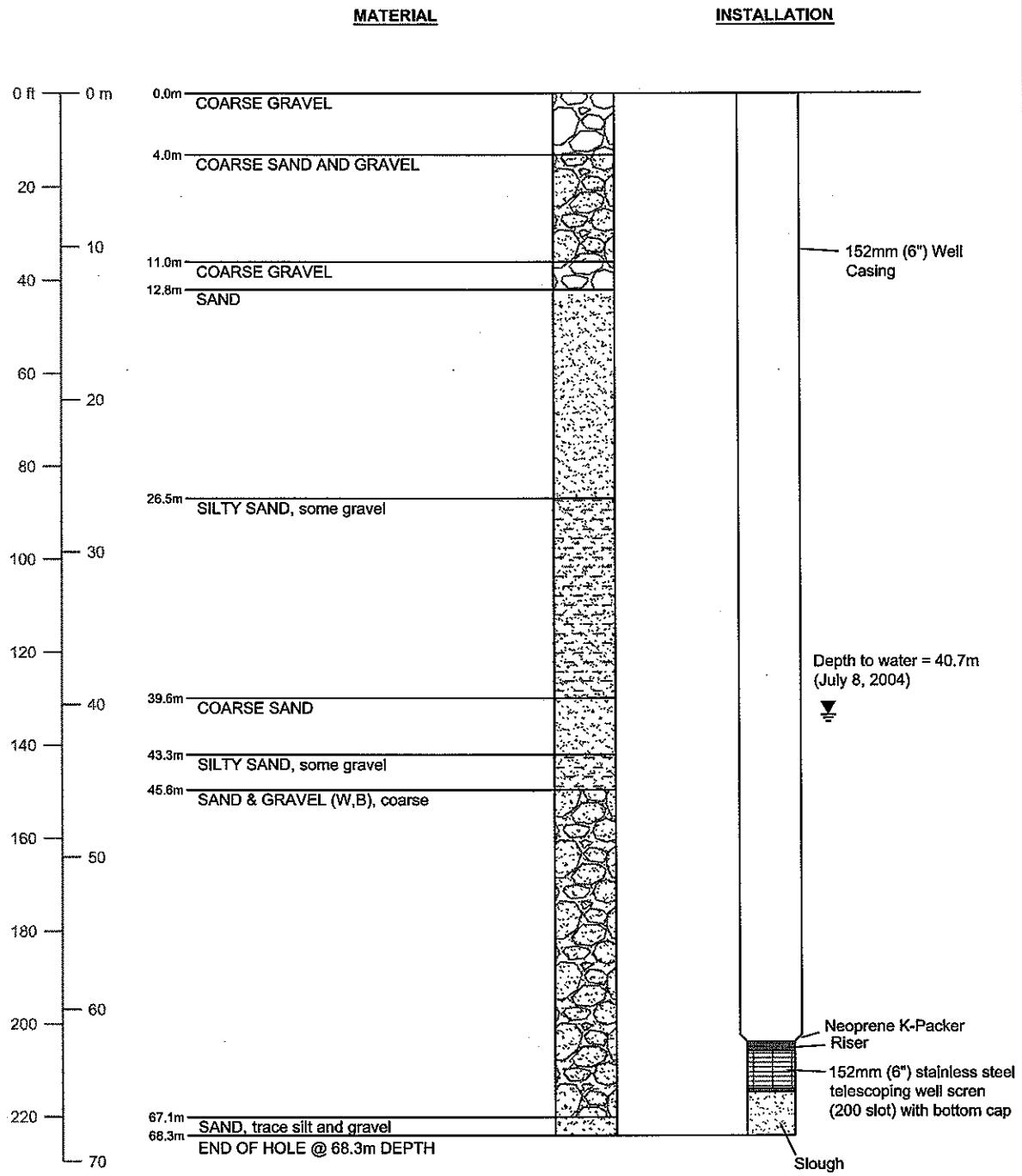
Annual Groundwater Monitoring	BECK Drilling and Environmental Services	BOREHOLE NO: AMOC – 1
Regional District of Comox–Strathcona	Acker Tractor Air Rotary Drill	PROJECT NO:
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | OTHER

Depth(m)	SOIL SYMBOL	Soil Description	SLOTTED PIEZOMETER	Depth(ft)
0.0		SAND and GRAVEL – brown, dry, cobbles to 0,15 m diametre		0.0
		SAND – fine grained, grey, dry		
		SAND and GRAVEL – grey, dry		10.0
5.0		SAND – medium grained, grey, damp		
		SAND – some gravel, medium grained, grey, damp		20.0
10.0				30.0
				40.0
15.0		SAND – trace silt, medium grained, brown, moist		50.0
		SAND – some gravel, medium grained, brown, damp		60.0
20.0				70.0
25.0		SAND and GRAVEL – medium grained, brown, damp		80.0
		SAND – coarse grained, brown, wet – Groundwater encountered at 25.9 m.		90.0
30.0				100.0
		End of Hole at 33.2 m. Monitoring well installed to 32 m. Screened from 19.8 to 32 m.		110.0
35.0				120.0
40.0				

AMEC Earth & Environmental Limited

LOGGED BY: ARM | COMPLETION DEPTH: 33.2 m
REVIEWED BY: CT | COMPLETED:



VERTICAL SCALE 1:400

4 0 4 10 16m

EBA Engineering Consultants Ltd.				PROJECT	INSTALLATION OF PROD. WELL AND ADDITIONAL MONITORING WELLS, CAMPBELL RIVER LANDFILL
CLIENT	REGIONAL DISTRICT OF COMOX-STRATHCONA			TITLE	EBA04-1 WELL SCHEMATIC
DATE	2004/08/17	DWN. YL	CHKD. SB	FILE NO.	0807-2840017.010

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-2
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
0.0		GRAVEL CAP			0.0
1.0		WOOD FIBRE			5.0
2.0		GARBAGE			10.0
3.0		WOOD FIBRE			15.0
4.0		GARBAGE			20.0
5.0		SAND & GRAVEL	CASING LEFT IN GROUND TO DEPTH OF 33.5m.		25.0
6.0					30.0
7.0					35.0
8.0		COARSE GRAVEL			40.0
9.0					45.0
10.0					50.0
11.0					55.0
12.0					60.0
13.0					65.0
14.0					70.0
15.0					75.0
16.0					80.0
17.0					85.0
18.0					90.0
19.0					95.0
20.0					100.0
21.0					105.0
22.0					110.0
23.0					
24.0					
25.0					
26.0					
27.0					
28.0					
29.0					
30.0					
31.0					
32.0					
33.0					
34.0					
35.0					

EBA Engineering Consultants Ltd.	LOGGED BY: MK	COMPLETION DEPTH: 65.5 m
	REVIEWED BY: SB	COMPLETE: 07/07/04
		Page 1 of 2

04/12/16 02:57PM (SHELLY)

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-2
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
35.0					115.0
36.0					120.0
37.0					125.0
38.0					130.0
39.0					
40.0					
41					135
42.0					140.0
43.0		SAND & GRAVEL			145.0
44.0					
45.0					150.0
46.0					
47.0					155.0
48.0					
49.0					160.0
50.0					
51.0					165.0
52.0					
53.0					170.0
54.0					
55.0					175.0
56.0					
57.0					180.0
58.0					
59.0					185.0
60.0					
61.0					190.0
62.0					
63.0					195.0
64.0					
65.0					200.0
66.0		END OF HOLE @ 65.5m BELOW SURFACE			205.0
67.0		NOTE: SOILS LOGGED BY DRILLWELL STAFF.			210.0
68.0					215.0
69.0					220.0
70.0					225.0

EBA Engineering Consultants Ltd.

LOGGED BY: MK	COMPLETION DEPTH: 65.5 m
REVIEWED BY: SB	COMPLETE: 07/07/04

04/12/16 02:57PM (SHELLY)

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-3
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
0.0		SAND	CASING LEFT IN GROUND TO DEPTH OF 11.2m.		0.0
5.0		SAND, some gravel			15.0
8.0		SAND AND GRAVEL			25.0
13.0		SILTY SAND			40.0
14.0		FINE SAND			45.0
17.0		COARSE SAND			55.0
18.0		FINE SAND, some silt			60.0
33.0		SAND AND GRAVEL			110.0
35.0					

EBA Engineering Consultants Ltd.

LOGGED BY: MC | COMPLETION DEPTH: 41.2 m
REVIEWED BY: SB | COMPLETE: 07/07/04

04/12/16 12:10PM (SHELLY)

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-3
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
35.0 - 41.0					115.0 - 135.0
41.0		END OF HOLE @ 41.2 m BELOW SURFACE NOTE: SOILS LOGGED BY DRILLWELL STAFF.			
42.0 - 70.0					140.0 - 225.0

EBA Engineering Consultants Ltd.	LOGGED BY: MC	COMPLETION DEPTH: 41.2 m
	REVIEWED BY: SB	COMPLETE: 07/07/04
		Page 2 of 2

04/12/16 12:10PM (SHELLY)

Monitoring Wells Campbell River Landfill	Sonic Drilling Ltd.	BOREHOLE NO: EBA04-4
Regional District of Comox-Strathcona	Drilling Method: Sonic	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
0.0		GARBAGE			0.0
21.0		SAND, fine to medium grained, well sorted, loose, damp			
25.0		SILT, occasional gravel, trace silt, compact, moist			
26.0		SAND, fine to medium grained, well sorted			
27.0		SILT & CLAY with trace sand			
28.0		SAND and SAND & GRAVEL interlayers			
35.0					

EBA Engineering Consultants Ltd.

LOGGED BY: MC
REVIEWED BY: SB

COMPLETION DEPTH: 53.4 m
COMPLETE: 15/07/04

04/12/16 02:51PM (SHELLY)

Monitoring Wells Campbell River Landfill	Sonic Drilling Ltd.	BOREHOLE NO: EBA04-4
Regional District of Comox-Strathcona	Drilling Method: Sonic	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
35.0 to 53.0					115.0 to 175.0
53.0		END OF HOLE @ 53.3 m BELOW SURFACE NOTE: SOILS LOGGED BY EBA STAFF.			
54.0 to 70.0					180.0 to 225.0

EBA Engineering Consultants Ltd.

LOGGED BY: MC | COMPLETION DEPTH: 53.4 m
REVIEWED BY: SB | COMPLETE: 15/07/04

04/12/16 02:51PM (SHELLY)

Monitoring Wells Campbell River Landfill	Sonic Drilling Ltd.	BOREHOLE NO: EBA04-5
Regional District of Comox-Strathcona	Drilling Method: Sonic	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
0.0		GARBAGE			0.0
19.0		SAND & GRAVEL, medium to coarse grained, sub-angular, compact moist			65.0
28.0		SILT & GRAVEL, moist			90.0
29.0		SAND & GRAVEL, poorly graded, compact, moist			95.0
35.0					110.0

WELLSCREEN FULL OF BENTONITE, WELL TO BE REDRILLED.

EBA Engineering Consultants Ltd.

LOGGED BY: MC	COMPLETION DEPTH: 67.1 m
REVIEWED BY: SB	COMPLETE: 07/07/04

04/12/16 02:51PM (SHELLY)

Monitoring Wells Campbell River Landfill	Sonic Drilling Ltd.	BOREHOLE NO: EBA04-5
Regional District of Comox-Strathcona	Drilling Method: Sonic	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
35.0					115.0
36.0					120.0
37.0					125.0
38.0					130.0
39.0					135.0
40.0					140.0
41.0					145.0
42.0					150.0
43.0					155.0
44.0					160.0
45.0					165.0
46.0					170.0
47.0					175.0
48.0					180.0
49.0					185.0
50.0					190.0
51.0					195.0
52.0					200.0
53.0					205.0
54.0		– some cobbles @ 53.3m – little recovery between 53.3 to 67.1m			210.0
55.0					215.0
56.0					220.0
57.0					225.0
58.0					
59.0					
60.0					
61.0					
62.0					
63.0					
64.0					
65.0					
66.0					
67.0		END OF HOLE @ 67.1 m BELOW SURFACE NOTE: SOILS LOGGED BY EBA STAFF.			
68.0					
69.0					
70.0					

EBA Engineering Consultants Ltd.

LOGGED BY: MC | COMPLETION DEPTH: 67.1 m
REVIEWED BY: SB | COMPLETE: 07/07/04

04/12/16 02:51PM (SHELLY)

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-6
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes
0.0		SAND	CASING LEFT IN GROUND TO DEPTH OF 26.2m.
5.0		SAND, some gravel	
6.0		COARSE GRAVEL	
10.0		SAND & FINER GRAVEL	
15.0		SILTY SAND	
16.0		SAND	
23.0		SAND & GRAVEL, slightly silty	
25.0		SILTY SAND, brown	
29.0		SAND & GRAVEL	

SLOTTED PIEZOMETER

Depth(ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0, 100.0, 105.0, 110.0

EBA Engineering Consultants Ltd.

LOGGED BY: MC | COMPLETION DEPTH: 39.6 m
REVIEWED BY: SB | COMPLETE: 13/07/04

04/12/16 12:10PM (SHELLY)

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-6
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
35.0					115.0
36.0					120.0
37.0					125.0
38.0					130.0
39.0					135.0
40.0		END OF HOLE @ 39.6 m BELOW SURFACE			140.0
41.0		NOTE: SOILS LOGGED BY DRILLWELL STAFF.			145.0
42.0					150.0
43.0					155.0
44.0					160.0
45.0					165.0
46.0					170.0
47.0					175.0
48.0					180.0
49.0					185.0
50.0					190.0
51.0					195.0
52.0					200.0
53.0					205.0
54.0					210.0
55.0					215.0
56.0					220.0
57.0					225.0
58.0					
59.0					
60.0					
61.0					
62.0					
63.0					
64.0					
65.0					
66.0					
67.0					
68.0					
69.0					
70.0					

EBA Engineering Consultants Ltd.	LOGGED BY: MC	COMPLETION DEPTH: 39.6 m
	REVIEWED BY: SB	COMPLETE: 13/07/04
		Page 2 of 2

04/12/16 12:10PM (SHELLY)

Monitoring Wells Campbell River Landfill	Drillwell Enterprises Ltd.	BOREHOLE NO: EBA04-7
Regional District of Comox-Strathcona	Drilling Method: Air Rotary	PROJECT NO: 2840017.010
		ELEVATION:

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth(m)	SOIL SYMBOL	Soil Description	Field Notes	SLOTTED PIEZOMETER	Depth(ft)
0.0		SAND	CASING LEFT IN GROUND TO DEPTH OF 11.2m		0.0
5.0		SAND, some gravel			15.0
6.0		COARSE GRAVEL			20.0
7.0		SAND & GRAVEL			25.0
15.0		SILTY SAND			50.0
16.0		SAND			55.0
23.0		SAND & GRAVEL, some silt			75.0
25.0		SILTY SAND, brown			80.0
29.0		SAND & GRAVEL			95.0
32.0		END OF HOLE @ 32.0 m BELOW SURFACE NOTE: SOILS LOGGED BY DRILLWELL STAFF.			105.0
35.0					110.0

EBA Engineering Consultants Ltd.

LOGGED BY: MC	COMPLETION DEPTH: 32 m
REVIEWED BY: SB	COMPLETE: 17/07/04

04/12/16 12:10PM (SHELLY)

Project: Stage 2 PSI	Client: Comox Valley Regional District	PROJECT NO. - BOREHOLE NO.
Location: Block J, CRWMC	Drilling Contractor: Drillwell Enterprises	N23101802 - EBA11-01
Client: Campbell River, BC	Drilling Method: Air Rotary	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	USC	SOIL SYMBOL	NOTES & COMMENTS	EBA11-01	Depth (ft)
0	SAND, fine grained, loose, homogeneous, damp, orange and white						0
	SAND, fine to medium grained, loose, moist, grey						5
							10
							15
	- Trace silt at 6.1 m						20
							25
	- Compact at 8.5 m						30
10	SAND, fine grained, trace gravel, small, grey						35
	- Trace silt at 11.3 m - No silt at 11.7 m						40
							45
	- Coarse sand at 14.3 m		SW				50
	SAND, fine grained, homogenous moist, brown - Trace small gravel at 15.2 m						55
							60
	SAND, trace to some silt, very fine grained, moist, grey						65
20	- Silty at 19.8 m						70
	- Moist to wet at 20.7 m						75
	November 17, 2011						80
	- Saturated at 23.2 m						85
							90
							95
	End of hole at 29.0 m						100
30							105
							110
35							115

November 17, 2011

eba A TETRA TECH COMPANY

LOGGED BY: MG	COMPLETION DEPTH: 28.96 m
REVIEWED BY:	COMPLETE: 11/15/2011
DRAWING NO: 1	Page 1 of 1

Project: Subsurface Investigation	Client: Comox Valley Regional District	PROJECT NO. - BOREHOLE NO.
Location: Block J, CRWMC	Drilling Contractor: Drillwell Enterprises	N23101803 - EBA11-02
City: Campbell River, BC	Drilling Method: Air Rotary	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	USC	SOIL SYMBOL	NOTES & COMMENTS
0	SAND (FILL), some gravel, fine to coarse grained, loose, brown		FILL		
	SAND, trace to some gravel, fine to medium grained, loose, damp, grey and brown		SW		
20	SAND, fine to medium grained, loose, moist, brown				
	November 17, 2011				
	SAND, silty, very fine grained, saturated, grey - Saturated at 26.5 m		SM		
30	SILT, sandy, fine grained, soft, grey		ML		
	SAND, gravelly, trace silt, medium to coarse grained, loose, saturated, grey		SW		
40	End of hole at 35.0 m				

EBA11-02

Depth (ft): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130

November 16, 2011

eba A TETRA TECH COMPANY	LOGGED BY: MG	COMPLETION DEPTH: 35 m
	REVIEWED BY:	COMPLETE: 11/16/2011
	DRAWING NO: 6	Page 1 of 1

Project: Stage 2 PSI	Client: Comox Valley Regional District	PROJECT NO. - BOREHOLE NO.
Location: Block J, CRWMC	Drilling Contractor: Drillwell Enterprises	N23101802 - EBA11-03
Client: Campbell River, BC	Drilling Method: Air Rotary	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	USC	SOIL SYMBOL	NOTES & COMMENTS	Depth (ft)
0	ORGANICS (FOREST FLOOR), silt, trace sand, soft, moist, dark brown		TOPSOIL			0
	SILT, trace sand, trace organics, fine to coarse grained, soft, moist, reddish brown		SM			5
	SILT, trace clay, stiff, moist, light brown		SC			10
	SAND, fine to medium grained, loose, damp, tan coloured					15
	- Brown at 6.1 m					20
	- Compact at 7.9 m					25
	- Loose at 8.8 m					30
10						35
						40
						45
						50
			SW			55
						60
	SAND, fine to coarse grained, moist, grey					65
20						70
November 17, 2011	- Saturated at 22.6 m, trace gravel					75
						80
						85
						90
	SILT, sandy, trace gravel, very fine grained, soft, saturated, grey		SM			95
30	End of hole at 30.1 m					100
						105
						110
35						115

EBA11-03

November 17, 2011

eba A TETRA TECH COMPANY	LOGGED BY: MG	COMPLETION DEPTH: 30.175 m
	REVIEWED BY:	COMPLETE: 11/17/2011
	DRAWING NO: 2	Page 1 of 1

Project: Stage 2 PSI	Client: Comox Valley Regional District	PROJECT NO. - BOREHOLE NO.
Location: Block J, CRWMC	Drilling Contractor: Drillwell Enterprises	N23101802 - EBA11-04
Client: Campbell River, BC	Drilling Method: Air Rotary	

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	USC	SOIL SYMBOL	NOTES & COMMENTS	EBA11-04	Depth (ft)
0	SILT, sandy, trace organics, soft, moist, reddish brown		ML				0
	SAND, fine grained, loose, homogenous, moist, tan coloured						5
	- Grey at 3.1 m						10
							15
							20
							25
10							30
			SW				35
							40
							45
							50
							55
							60
	SAND, trace gravel, fine to medium grained, compact						65
20							70
	SILT, sandy, fine grained, trace gravel, moist to wet, grey		ML				75
							80
	SAND, trace gravel, trace silt, saturated, tan coloured		SW				85
	SILT, sandy, soft, saturated, grey		ML				90
	SAND, very fine grained, some silt, saturated, grey		SM				95
30	End of hole at 29.6 m						100
							105
							110
35							115

November 17, 2011

November 17, 2011

eba A TETRA TECH COMPANY	LOGGED BY: MG	COMPLETION DEPTH: 29.57 m
	REVIEWED BY:	COMPLETE: 11/17/2011
	DRAWING NO: 3	Page 1 of 1

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: Campbell River Waste Management Centre
HOLE DESIGNATION: MW01-16
PROJECT NUMBER: 056484
DATE COMPLETED: 21 June 2016
CLIENT: Comox Valley Regional District
DRILLING METHOD: Rotosonic (153 mm)
LOCATION: Campbell River, BC
FIELD PERSONNEL: S. Foster
DRILLING CONTRACTOR: Mud Bay Drilling

NORTHING: 5542091
EASTING: 331111

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m
	TOP OF RISER	186.68
	GROUND SURFACE	185.94
0	OL-SILT, with gravel (organic topsoil), loose, silt to fine gravel, dark brown, dry	185.64
1	GW-GRAVEL with cobbles, with silt/fine sand, loose, brown, dry	
2	- silt and sand with cobbles layer (0.3 m) at 1.83m BGS	
		183.50
3	SP-gravelly SAND, medium sand, minor coarse sand, fine to coarse gravel, light grey, dry	182.90
4	SW/GW-SAND and GRAVEL, with cobbles, fine sand, fine to coarse gravel, cobbles, tight, grey, moist	
5		
		180.46
6	SW-gravelly SAND, trace cobble, fine sand (less medium, less coarse), fine gravel (less coarse), light grey dry	
7		
8		
9		
10		175.88
11	SP-SAND, fine sand, light brown, slightly moist	174.97
12	GM-SILTY SAND and GRAVEL, silt with fine to coarse sand, with fine to coarse gravel, light grey, dry	174.06
13	SW/GW-SAND and GRAVEL, trace silt, well graded, fine to coarse sand, fine to coarse gravel, grey, moist	
14		
15		171.01
16	SP-SAND, trace silt, trace gravel, medium to coarse grain sand, fine gravel, brown, moist	
17	- trace cobble at 16.46m BGS	
18		167.96
19	SW/GW-SAND and GRAVEL, fine to coarse sand, fine to coarse gravel, trace silt, brown, moist	

BOREHOLE: STICKUP 0.80 M; BENTONITE CHIP AND SOIL CUTTINGS; 51 mm Ø PVC RISER PIPE; 152 mm Ø BOREHOLE; BENTONITE/SOIL CUTTINGS

SAMPLE NUMBER	INTERVAL	REC (%)	'N' VALUE
RS-1		100	
RS-2		100	
RS-3		100	
RS-4		100	
RS-5		100	
RS-6		100	
RS-7		100	
RS-8		100	

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STATIC WATER LEVEL ▼ June 29, 2016

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: Campbell River Waste Management Centre
HOLE DESIGNATION: MW01-16
PROJECT NUMBER: 056484
DATE COMPLETED: 21 June 2016
CLIENT: Comox Valley Regional District
DRILLING METHOD: Rotosonic (153 mm)
LOCATION: Campbell River, BC
FIELD PERSONNEL: S. Foster
DRILLING CONTRACTOR: Mud Bay Drilling

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m	BOREHOLE	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
21	GM-GRAVEL (TILL), with silt/fine sand, fine to coarse gravel, fine sand (less medium/coarse), very dense, clumpy, gravel rounded to subrounded, grey to brown, moist	165.52					
22	- core through boulder at 21.03m BGS						
23				RS-9		100	
24							
25							
26				RS-10		100	
27							
28	SP-SAND with gravel, fine to coarse sand, fine gravel, subrounded, brown, grey, moist	157.90		RS-11		100	
29	SW/GW-SAND and GRAVEL trace silt, trace cobbles, fine to coarse sand, fine to coarse gravel, subrounded, brown, moist	156.99	▼	RS-12		100	
30	- trace cobbles at 29.26m BGS - becoming wet at 29.87m BGS						
31	- trace cobbles at 31.39m BGS						
32				RS-13		100	
33	- increase in silt, return on water, cloudy at 33.22m BGS						
34							
35	- orange brown, sandy silt layer, 5 cm thickness at 34.75m BGS - slow drilling, hard at 35.05m BGS		BENTONITE PELLETS	RS-14		100	
36							
37							
38			SILICA SAND	RS-15		100	
39	- sandy till with gravel at 39.01m BGS		51 mm Ø 10-SLOT PVC SCREEN				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STATIC WATER LEVEL ▼ June 29, 2016

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

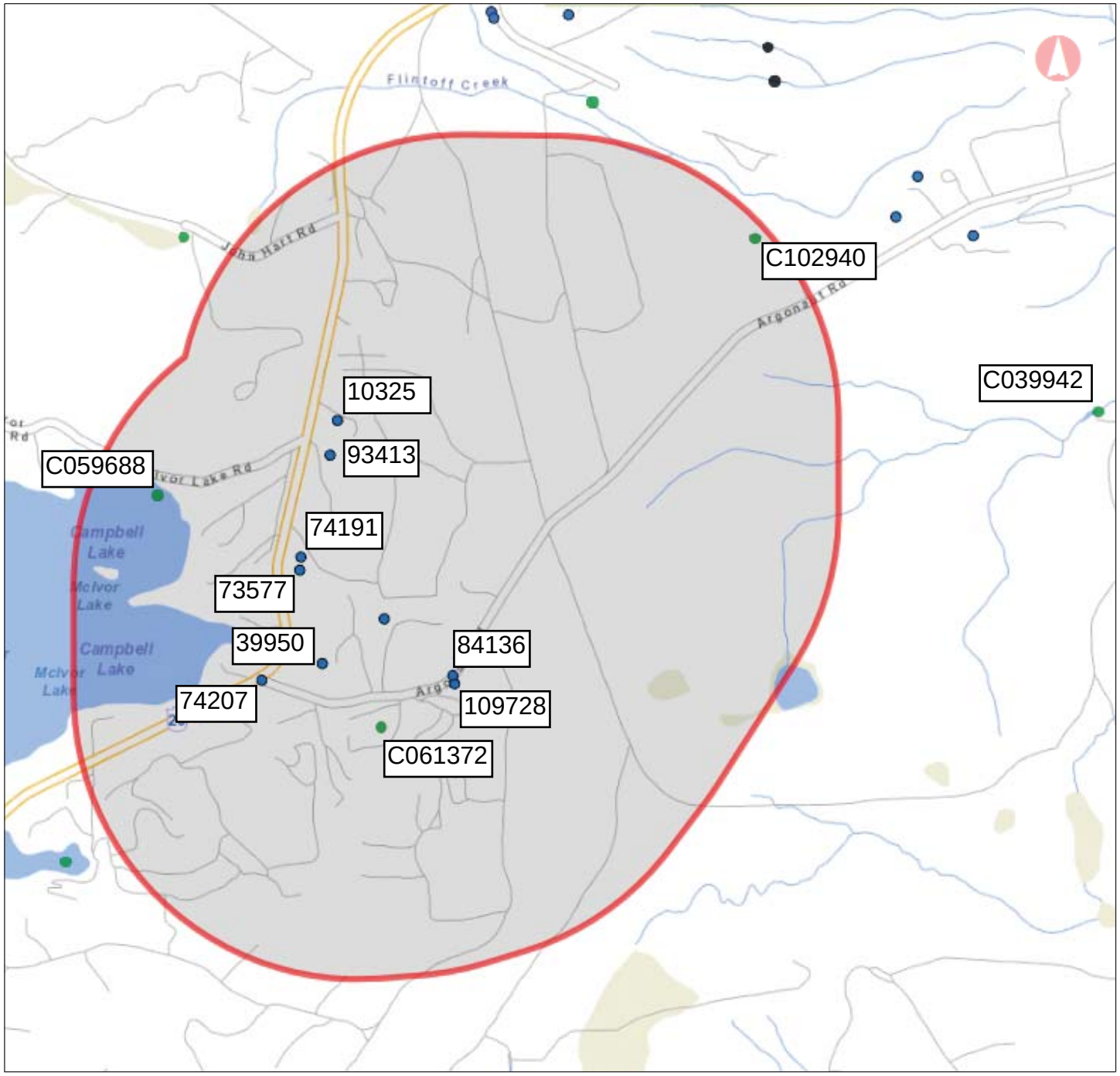
PROJECT NAME: Campbell River Waste Management Centre
HOLE DESIGNATION: MW01-16
PROJECT NUMBER: 056484
DATE COMPLETED: 21 June 2016
CLIENT: Comox Valley Regional District
DRILLING METHOD: Rotosonic (153 mm)
LOCATION: Campbell River, BC
FIELD PERSONNEL: S. Foster
DRILLING CONTRACTOR: Mud Bay Drilling

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m	BOREHOLE	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
41				RS-16		100	
42			CAVE IN				
	END OF BOREHOLE @ 42.37m BGS	143.58					
43	Monitoring well completed in saturated conditions.		WELL DETAILS Screened interval: 145.10 to 148.15m 40.84 to 37.80m BGS Length: -3.05m Diameter: 51mm Slot Size: 20 Material: SCH. 40 PVC Seal: 149.67 to 151.50m 36.27 to 34.44m BGS Material: BENTONITE GRAVEL Sand Pack: 145.10 to 149.67m 40.84 to 36.27m BGS Material: TARGET FILTER SAND 10/20 --- Seal: 151.50 to 185.94m 34.44 to 0.00m BGS Material: BENTONITE CHIP AND DRILL CUTTINGS				
44	Initial static water level elevated above normal due to addition of water during drilling.						
45	Borehole backfilled with bentonite gravel, and a mixture of soil cuttings and bentonite chip.						
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STATIC WATER LEVEL ▼ June 29, 2016

Appendix C
Surrounding Water Use



BRITISH COLUMBIA

Well Licenses and Surface Water Points of Diversion

Legend

Points of Diversion

STATUS

- Active Application
- Active Application and Licence
- Inactive
- Active Licence

- Water Wells - All
- Water Wells - Lithology
- Water Wells - Private Dome
- Water Wells - Licensed/Unli

WELL_LICENCE_GENERAL_S

- Licensed
- Unlicensed

- Water Wells - Artesian

0 0.41 0.81 km

1: 20,000

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Datum: NAD83

Projection: NAD_1983_BC_Environment_Albers

Key Map of British Columbia



WATER RESOURCES SERVICE
WATER RIGHTS BRANCH

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

The Honourable the Minister of the Environment (Fisheries Service) of OTTAWA, Ontario

is/are hereby authorized to divert and use water as follows:—

(*a*) The source(s) of the water-supply is/are Cold Creek.

(*b*) The point(s) of diversion is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is 8th May, 1970.

(*d*) The purpose for which the water is to be used is conservation (hatchery).

(*e*) The maximum quantity of water which may be diverted is 30 cubic feet per second, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be used is the whole year.

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is Lot 80, Sayward District.

(*h*) The works authorized to be constructed are diversion structure and pipe, which shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works shall be commenced on or before the 31st day of May, 1973, and shall be completed and the water beneficially used on or before the 31st day of December, 1976.

H. D. DeBeck,
Comptroller of Water Rights.

File No. 0296403 Date issued: 1 November 1972 Conditional Licence No. 39942

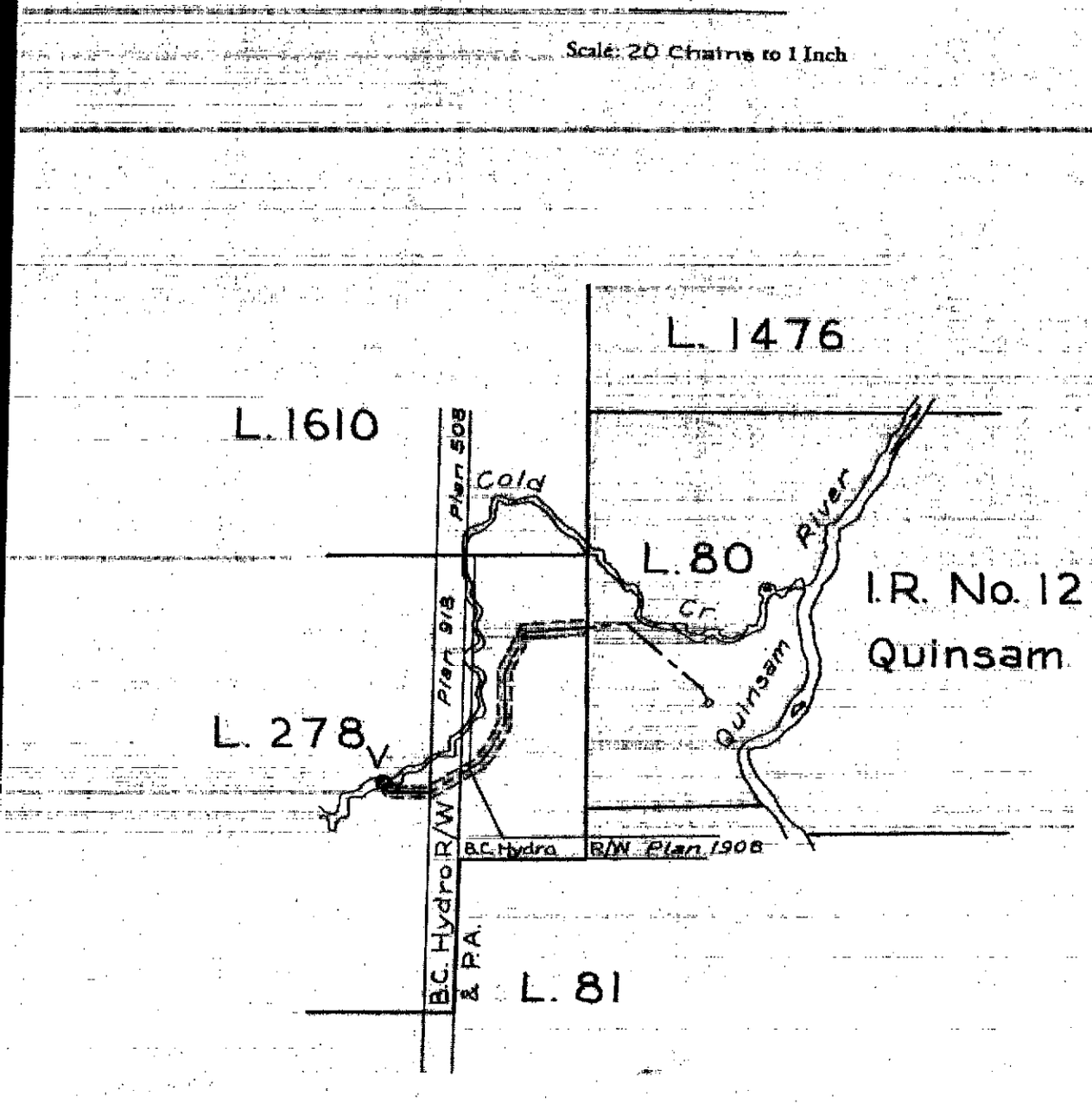
ENTERED ON
Map No. 4824
By GHR CB

British Columbia

NANAIMO WATER DISTRICT

SAYWARD DISTRICT

Scale: 20 Chains to 1 Inch



LEGEND

Point of Diversion ●

W.R. Map 4824

Pipe

Right of Way

The boundaries of the land to which this licence is appurtenant are shown thus:

Signature

Date 1st Nov. 1972

CL 39942

File 0296403

R/W Permit 8754

Courtenay Precinct

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Tayco Paving Company Limited of 851 Fifth Street, Courtenay, B.C. V9N 1K8 is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Campbell Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 27th July, 1983.

(d) The purpose for which the water is to be used is industrial (dust control).

(e) The maximum quantity of water which may be diverted is 1000 gallons per day.

(f) The period of the year during which the water may be used is the whole year.

(g) The land upon which the water is to be used and to which this licence is appurtenant is Block of Lot 84, Sayward District.

(h) The works authorized to be constructed are intake, pump, pipe and holding ponds which shall be located approximately as shown on the attached plan.

(i) The construction of the said works has been completed and the water shall be beneficially used on or before the 31st day of December, 1986.

ENTERED ON
Map No. _____
By LK

B. Hollingshead
Regional Water Manager

File No. 1000194 Date issued: 23rd November, 1984 Conditional Licence 59688

AMENDED 30.11.84

W-183

ORDER

WATER ACT

Section 15

File No. 1000194

In the matter of Conditional Water Licence 59688, which authorizes the diversion of water from Campbell Lake for industrial (dust control) purpose.

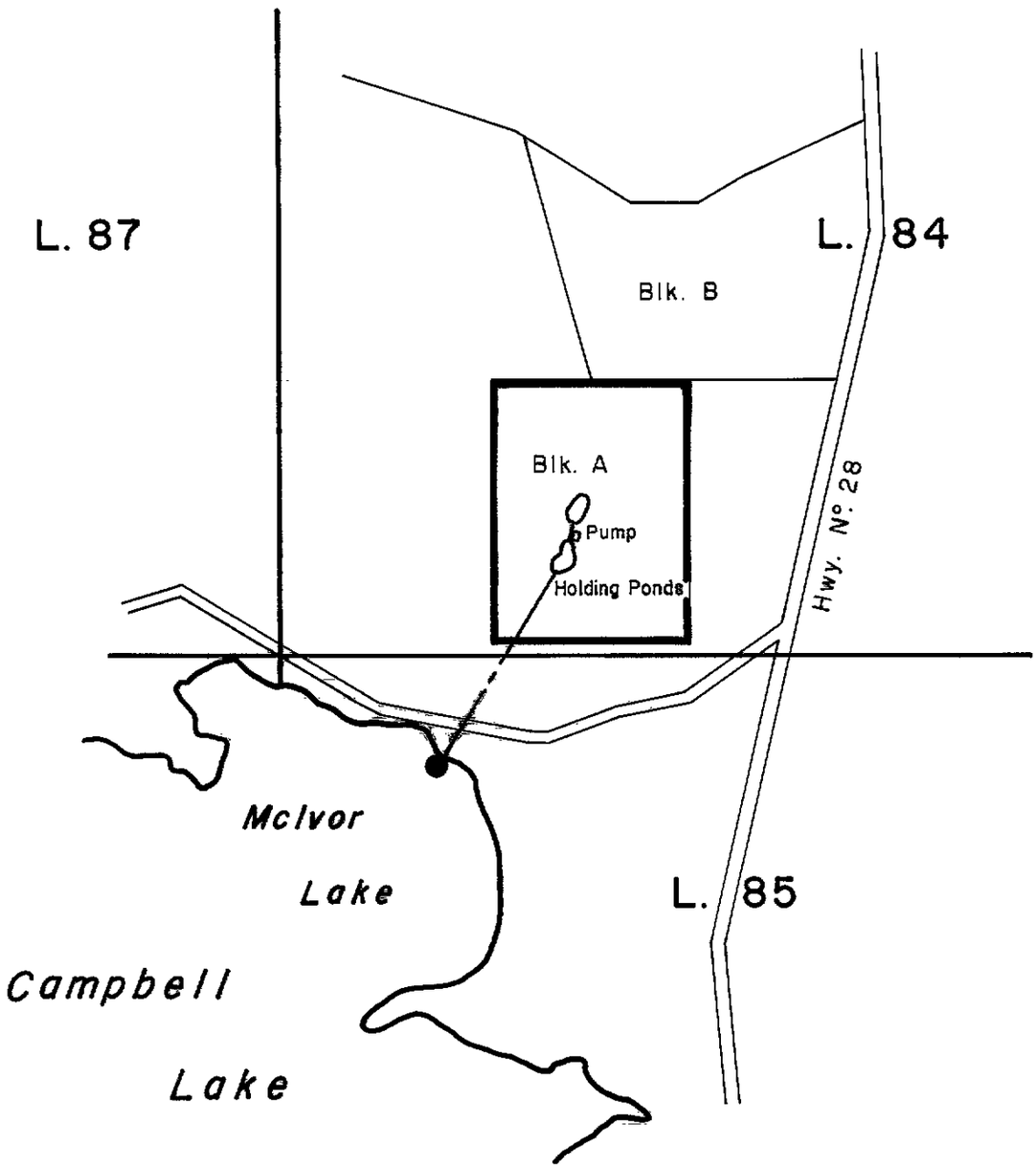
Having determined that the land upon which the water is to be used and to which said licence is appurtenant has been incorrectly described, and being satisfied that no persons rights will be injuriously affected I hereby amend clause (g) of said licence to read as follows:

(g) The land upon which the water is to be used and to which this licence is appurtenant is Block A of Lot 84, Sayward District.

Dated at Nanaimo, B. C., this 30th day of November, 1984.

B. Hollingshead
Regional Water Manager

Province of British Columbia



WATER DISTRICT : NANAIMO
PRECINCT : COURTENAY
LAND DISTRICT : SAYWARD

LEGEND

Scale : 1:10 000
Point of Diversion : ●
Map Number : WR 92K/3c
Pipe : ——— - ———

Signature B Hollmann
Date 23 November 1984

C.L. 59688
File 1000194

The boundaries of the land to which this licence is appurtenant are shown thus: ▬▬▬

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Canfarge Limited of 1051 Main Street, Vancouver, British Columbia V9N 5N3 is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Antonelli Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 30th June, 1967.

(d) The purpose for which the water is to be used is industrial (gravel washing).

(e) The maximum quantity of water which may be diverted is 1 cubic foot per second and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be used is the whole year.

(g) The land upon which the water is to be used and to which this licence is appurtenant is Block A of Lot 85, Sayward District.

(h) The works authorized to be constructed are pump, pipe, settling pond and ditch, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works has been completed and the water shall be beneficially used on or before the 31st day of December, 1986.

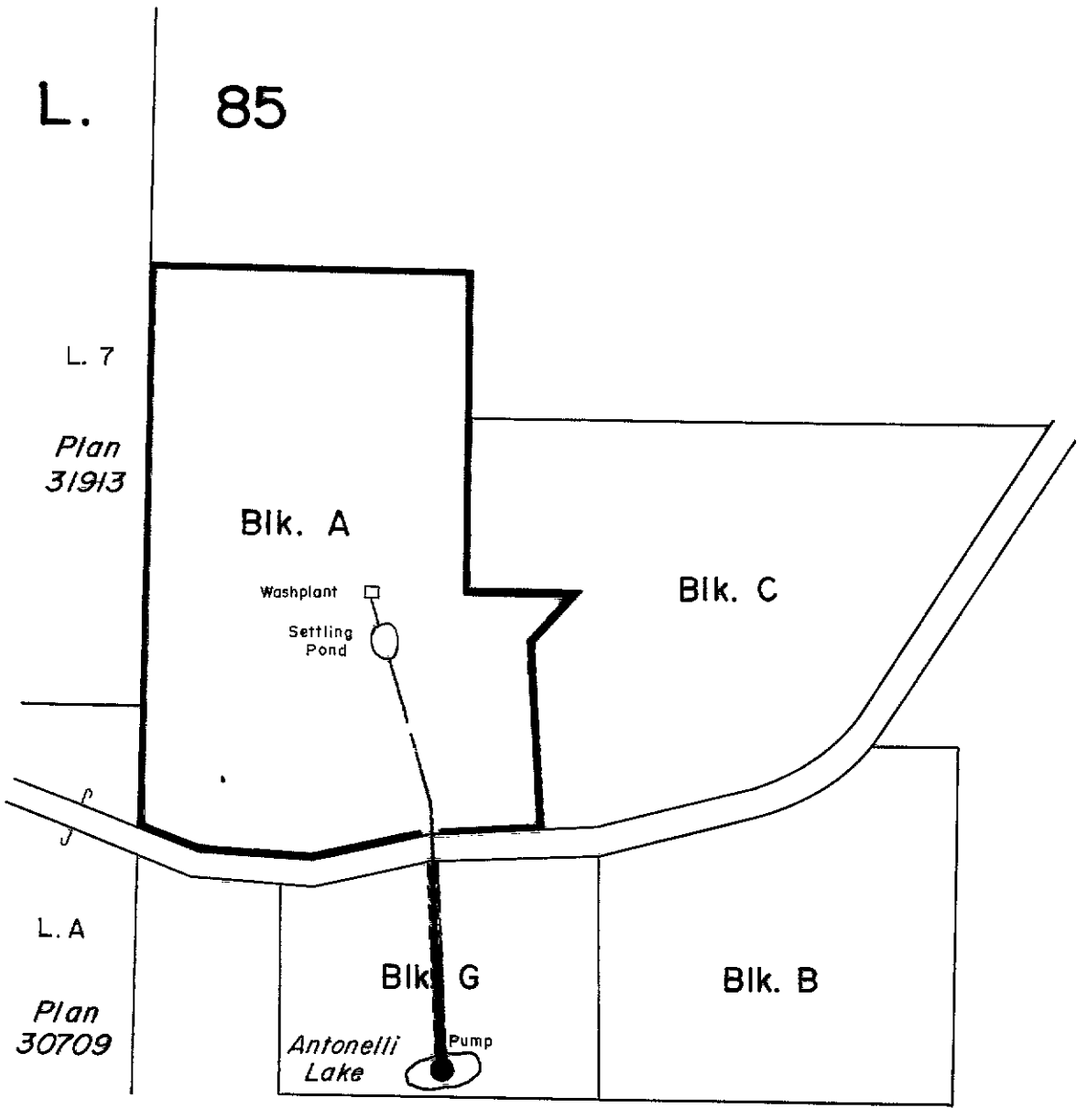
(j) This licence is issued in substitution of Conditional Water Licence 32774, under Section 16 of the Water Act.

B. Hollingshead
Regional Water Manager

File No. 0273655 Date issued: MAY 31 1985 Conditional Licence 61372

w

Province of British Columbia



WATER DISTRICT : NANAIMO
PRECINCT : SAYWARD
LAND DISTRICT : SAYWARD

LEGEND

Scale : 400 Feet to 1 Inch
Point of Diversion : ●
Map Number : WR 92 K/3c
Pipe : ———
Permit over Crown Land : ▬▬▬

The boundaries of the land to which this licence is appurtenant are shown thus: ▬▬▬

Signature [signature]

Date May 31, 1985

C.L. 61372 for C.L.32774
File 0273655
P.C.L. 14736

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT
Lands and Parks

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Carl Kolonsky of Box 336, Campbell River, British Columbia, V9W 5B6

is hereby authorized to store and use water as follows:

(a) The stream on which the rights are granted is Block Creek.

(b) The storage site is located as shown on the attached plan.

(c) (1) The date from which this licence shall have precedence is 6th June, 1980.

(2) The priority of this licence within the Campbell River watershed is subject to a Water Reserve established by Order in Council No. 1440, dated 5th November, 1940.

(d) The purpose for which this licence is issued is industrial (fish culture).

(e) The maximum quantity of water which may be stored is 2.5 acre feet per annum.

(f) The water may be used throughout the whole year, provided that the works authorized under this licence are being maintained and operated to the satisfaction of the Engineer under the Water Act.

(g) The land upon which the water is to be used and to which this licence is appurtenant is Block A of Lot 276, Sayward District, except Plan 38030.

(h) The works authorized to be constructed are dam and pond, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works has been completed and the water is being beneficially used. The licensee shall continue to make a regular beneficial use of the water in the manner authorized herein.

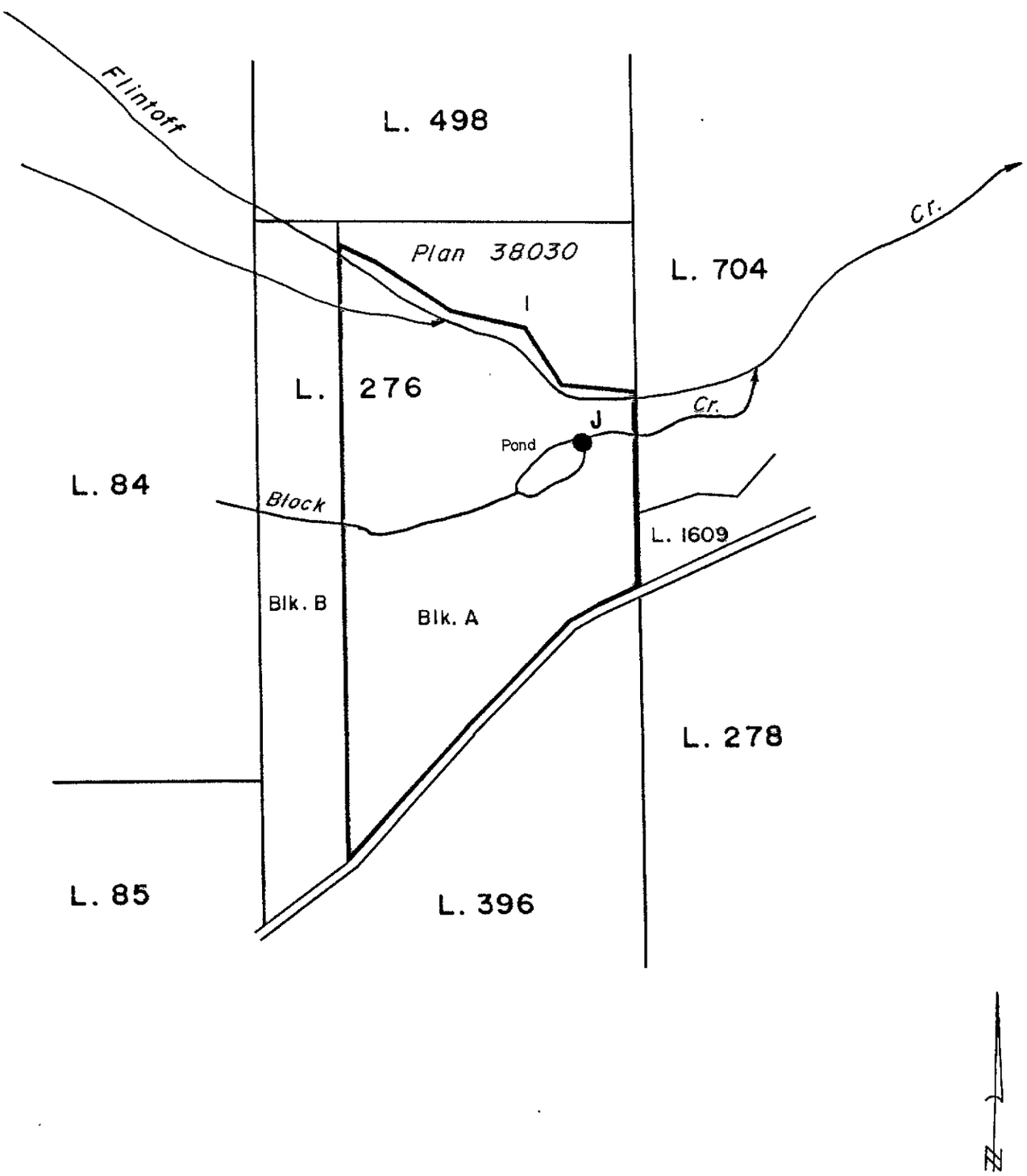
(j) This licence is issued in substitution of Conditional Water Licence 61361.

J. E. Farrell
Deputy Comptroller of Water Rights

File No. 0366710 Date issued: October 9, 1992 Conditional Licence 102940

W-183

Province of British Columbia



WATER DISTRICT : NANAIMO
PRECINCT : COURTENAY
LAND DISTRICT : SAYWARD

LEGEND

Scale : 1000 Feet to 1 Inch
Dam :
Map Number : WR 92K/3c

Signature ...
Date October 9, 1992

C.L. 102940 for C.L. 61361
File 0366710

The boundaries of the land to which this licence is appurtenant are shown thus: ———

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number:
Ministry Well Tag Number: 39950
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[ ] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: ISLAND READY MIX
Mailing address: "" Town Prov Postal Code
Well location: Street GOLD RIVER HIGHWAY NEAR DUMP Town CAMPBELL RIVER
(or) Legal description: Lot Plan D.L. Block Sec. 85 Twp. Rg. Land District SAYWARD
(or) PID: (and) Description of well location (attach sketch, if nec.):

NAD 83:Zone: 10 (see note 2) (and) UTM Northing: 5542131 m (or) Latitude (see note 3): 50º 00' 27.32"
UTM Easting: 331298 m Longitude: 125º 21' 16.03"

Method of drilling: [ ] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [ ] vertical [ ] horizontal Ground elevation: 0 ft (asl) Method (see note 4):
Class of well (see note 5): Sub-class of well:
Water supply wells, indicate intended water use: [ ] private domestic [ ] water supply system [ ] irrigation [X] commercial or industrial [ ] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	10				silty gravel		
10	55				sand & gravel		
55	55				sand		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Production Casing Diameter: 10.0 in
Surface seal: Type: Depth: ft
Method of installation: [ ] Poured [ ] Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [ ] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [ ] Telescope [ ] Pipe size
Screen material: [ ] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [ ] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [ ] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[ ] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

[ ] Pumping [ ] Air lifting [ ] Bailing [ ] Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[ ] Fresh [ ] Salty [ ] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19):
Registration no. (see note 20):
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: ft Finished well depth: 55 ft bgl
Final stick up: in Depth to bedrock: ft bgl
SWL: 7 ft (btoc) Estimated well yield: 0.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: Well disinfected: [ ] yes [X] no
Where well ID plate is attached:

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 1978/06/26 Completed:
Comment:

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number:
Ministry Well Tag Number: 73577
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[ ] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: FR FRANZEN CONSTUCTI
Mailing address: "" Town Prov Postal Code
Well location: Street Town
(or) Legal description: Lot 7 Plan 31913 D.L. Block Sec. Twp. Rg. Land District SAYWARD
(or) PID: 1125745 (and) Description of well location (attach sketch, if nec.): 4 MILES N OF C R ON GOLD R RD

NAD 83:Zone: 10 (see note 2) (and) UTM Northing: 5542462 m (or) Latitude (see note 3): 50º 00' 37.96"
UTM Easting: 331232 m Longitude: 125º 21' 19.86"

Method of drilling: [ ] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [ ] vertical [ ] horizontal Ground elevation: 0 ft (asl) Method (see note 4):
Class of well (see note 5): Sub-class of well:
Water supply wells, indicate intended water use: [X] private domestic [ ] water supply system [ ] irrigation [ ] commercial or industrial [ ] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	117				BLUE GRAVEL		
117	132				BLUE WATER BEARING SAND		
142	149				WATER BEARING SAND & GRAVEL		
138	142				WHITE WATER BEARING SAND		
132	138				BLUE WATER BEARING GRAVEL		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Production Casing Diameter: 0.0 in
Surface seal: Type: Depth: ft
Method of installation: [ ] Poured [ ] Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [ ] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [ ] Telescope [ ] Pipe size
Screen material: [ ] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [ ] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [ ] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[ ] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

[ ] Pumping [ ] Air lifting [ ] Bailing [ ] Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[ ] Fresh [ ] Salty [ ] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19):
Registration no. (see note 20):
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: ft Finished well depth: 149 ft bgl
Final stick up: in Depth to bedrock: ft bgl
SWL: 120 ft (btoc) Estimated well yield: 0.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: Well disinfected: [ ] yes [X] no
Where well ID plate is attached:

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 1981/03/09 Completed:
Comment: STEEL CASING, CONTINUOUS,

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number:
Ministry Well Tag Number: 74191
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[X] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: AL & SONS BACKHOE &
Mailing address: "" Town Prov Postal Code
Well location: Street GOLD RIVER HIGHWAY Town
or Legal description: Lot 2 Plan 47695 D.L. 85 Block Sec. Twp. Rg. Land District SAYWARD
or PID: 12474266 and Description of well location (attach sketch, if nec.):

NAD 83:Zone: 10 (see note 2) and UTM Northing: 5542508 m UTM Easting: 331238 m or Latitude (see note 3): 50º 00' 39.46" Longitude: 125º 21' 19.64"

Method of drilling: [ ] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [ ] vertical [ ] horizontal Ground elevation: 0 ft (asl) Method (see note 4):
Class of well (see note 5): Sub-class of well:
Water supply wells, indicate intended water use: [ ] private domestic [ ] water supply system [ ] irrigation [ ] commercial or industrial [X] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	20				GREY SAND & GRAVEL		
20	50				GREY SAND & GRAVEL		
50	75				BROWN SAND & GRAVEL		
122	124				WATER BEARING SAND & GRAVEL		
85	100				WATER BEARING SAND & GRAVEL		
100	125				WATERBEARING SAND & GRAVEL		
115	122				ROCKS & SAND		
75	85				BROWN SAND & GRAVEL		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Production Casing Diameter: 6.0 in
Surface seal: Type: Depth: ft
Method of installation: [ ] Poured [ ] Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [ ] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [ ] Telescope [ ] Pipe size
Screen material: [ ] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [ ] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [ ] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[ ] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

[ ] Pumping [ ] Air lifting [ ] Bailing [ ] Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[ ] Fresh [ ] Salty [ ] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19):
Registration no. (see note 20):
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: ft Finished well depth: 123 ft bgl
Final stick up: in Depth to bedrock: ft bgl
SWL: 80 ft (btoc) Estimated well yield: 100.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: Well disinfected: [ ] yes [X] no
Where well ID plate is attached:

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 1991/10/23 Completed: 1991/10/23
Comment: STEEL CASING,0.0 TO 123.2,.250 THICK,A53
LBS, CONTINUOUS,STAINLESS STEEL,PUMP TEST RATE 100 USGM,80 F

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number:
Ministry Well Tag Number: 74207
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[X] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: M & S FOREST PRODUCT
Mailing address: "" Town Prov Postal Code
Well location: Street GOLD RIVER HIGHWAY Town
(or) Legal description: Lot Plan D.L. 85 Block Sec. Twp. Rg. Land District SAYWARD
(or) PID: (and) Description of well location (attach sketch, if nec.): NEAR UPLAND EXCAVATING

NAD 83:Zone: 10 (see note 2) (and) UTM Northing: 5542081 m UTM Easting: 331083 m (or) Latitude (see note 3): 50º 00' 25.49" Longitude: 125º 21' 26.74"

Method of drilling: [ ] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [ ] vertical [ ] horizontal Ground elevation: 0 ft (asl) Method (see note 4):
Class of well (see note 5): Sub-class of well:
Water supply wells, indicate intended water use: [ ] private domestic [ ] water supply system [ ] irrigation [X] commercial or industrial [ ] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	93				BROWN SAND & GRAVEL		
100	138				WB SAND		
93	100				BROWN WB SAND & GRAVEL		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Production Casing Diameter: 7.0 in
Surface seal: Type: Depth: ft
Method of installation: [ ] Poured [ ] Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [ ] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [ ] Telescope [ ] Pipe size
Screen material: [ ] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [ ] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [ ] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[ ] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

[ ] Pumping [ ] Air lifting [ ] Bailing [ ] Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[ ] Fresh [ ] Salty [ ] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19):
Registration no. (see note 20):
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: ft Finished well depth: 138 ft bgl
Final stick up: in Depth to bedrock: ft bgl
SWL: 85 ft (btoc) Estimated well yield: 20.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: Well disinfected: [ ] yes [X] no
Where well ID plate is attached:

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 1987/05/01 Completed: 1987/05/01
Comment: STEEL CASING,0.0 TO 129.0,.250 THICK,53 LBS,
CONTINUOUS,STAINLESS STEEL,PUMP TEST RATE 20 USGM,5 FT AFTEI

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number:
Ministry Well Tag Number: 84136
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[ ] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: CAMPBELL RIVER LANDFILL
Mailing address: "" Town Prov Postal Code
Well location: Street 6700 ARGONAUT RD Town
(or) Legal description: Lot Plan D.L. Block Sec. Twp. Rg. Land District
(or) PID: (and) Description of well location (attach sketch, if nec.):

NAD 83:Zone: 10 (see note 2) (and) UTM Northing: 5542070 m (or) Latitude (see note 3): 50º 00' 25.81"
UTM Easting: 331755 m Longitude: 125º 20' 52.99"

Method of drilling: [X] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [ ] vertical [ ] horizontal Ground elevation: ft (asl) Method (see note 4):
Class of well (see note 5): Sub-class of well:
Water supply wells, indicate intended water use: [ ] private domestic [ ] water supply system [ ] irrigation [X] commercial or industrial [ ] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	13				COARSE GRAVEL		
13	36				COARSE SAND & GRAVEL		
36	42				COARSE GRAVEL		
42	87				BROWN SAND		
87	130				BROWN SILTY SAND & SOME GRAVEL		
130	142				CLEAN BROWN COARSE SAND		
142	150				SLIGHTLY SILTY SAND & GRAVEL		
150	220				COARSE SAND & GRAVEL (WB)		
220	224				MORE SAND & SILTYER BROWN WATER		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
206.3	215	5.5		200

Production Casing Diameter: 6.00 in
Surface seal: Type: Depth: ft
Method of installation: [ ] Poured [ ] Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [ ] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [X] Telescope [ ] Pipe size
Screen material: [X] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [ ] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [ ] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[ ] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

[ ] Pumping [ ] Air lifting [ ] Bailing [ ] Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[ ] Fresh [ ] Salty [ ] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19): DOUG WATT
Registration no. (see note 20):
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: ft Finished well depth: 215 ft bgl
Final stick up: in Depth to bedrock: ft bgl
SWL: ft (btoc) Estimated well yield: 75.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: Well disinfected: [ ] yes [X] no
Where well ID plate is attached:

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 2004/07/05 Completed: 2004/07/05
Comment: CHLORINE & WELDED LID

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

☐ **Well Construction Report**
☐ **Well Closure Report**
☒ **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number: 12472
Ministry Well Tag Number: 93413
Existing Well Tag Number:
☐ Confirmation/alternative specs. attached
☒ Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: EMCON (MINISTRY OF HIGHWAYS)
Mailing address: UNKNOWN Town CAMPBELL RIVER Prov BC Postal Code
Well location: Street 7025 GOLD RIVER HIGHWAY Town
or Legal description: Lot Plan D.L. 85 Block Sec. Twp. Rg. Land District RENFREW
or PID: and Description of well location (attach sketch, if nec.): BETWEEN BRINE TANK @ SHOP, SE PORTION OF PROPEI

NAD 83:Zone: 10 (see note 2) and UTM Northing: 5542862 m UTM Easting: 331355 m or Latitude (see note 3): 50º 00' 51.03" Longitude: 125º 21' 14.32"

Method of drilling: ☐ air rotary ☒ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):
Orientation of well: ☒ vertical ☐ horizontal Ground elevation: ft (asl) Method (see note 4):
Class of well (see note 5): Water supply Sub-class of well: Non-domestic
Water supply wells, indicate intended water use: ☐ private domestic ☐ water supply system ☐ irrigation ☒ commercial or industrial ☐ other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
160	178			medium	sand GRAVEL		
178	184						FINER & SANDIER AS GOING DEEPER
184	187		brown	silty	fine sand		
187	188		brown	silty	sand		VERY SILTY

Recom'd Pump Setting (depth) ft (bgl): 180

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
180	182	5	Riser Pipe	
182	186	5	K-packer	12

Production Casing Diameter: in
Surface seal: Type: Depth: ft
Method of installation: ☐ Poured ☐ Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: ☐ PVC ☐ Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: ☐ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☒ Telescope ☐ Pipe size
Screen material: ☒ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☒ Continuous slot ☐ Slotted ☐ Perforated Pipe
Screen bottom: ☐ Bail ☐ Plug ☐ Plate ☒ Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☐ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☒ Bailing
☐ Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

☐ Pumping ☐ Air lifting ☐ Bailing ☐ Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

☐ Fresh ☐ Salty ☐ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): CALVIN SLADE
Registration no. (see note 20): WD
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: 26 ft Finished well depth: 180 ft bgl
Final stick up: 24 in Depth to bedrock: ft bgl
SWL: 159 ft (btoc) Estimated well yield: 10.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: PITLESS UNIT & Well disinfected: ☐ yes ☒ no
Where well ID plate is attached:

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 2005/12/15 Completed: 2005/12/15
Comment: MEASUREMENTS FROM GROUND LEVEL. RECOMMENDED PUMPING RATE: 10 USGPM.

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number: 34915
Ministry Well Tag Number: 103257
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[X] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviatio**

Owner Name: TIM FLUTER (CONTACT) CAMPBELL RIVER MOTOCROSS ASSOCIATION
Mailing address: 3814 ISLAND HIGHWAY SOUTH Town CAMPBELL RIVER Prov BC Postal Code V9A 1M6
Well location: Street GOLD RIVER HIGHWAY Town CAMPBELL RIVER
(or) Legal description: Lot Plan D.L. Block Sec. Twp. Rg. Land District
(or) PID: (and) Description of well location (attach sketch, if nec.): NOT PROVIDED

NAD 83:Zone: 10 (see note 2) (and) UTM Northing: 5542983 m UTM Easting: 331386 m (or) Latitude (see note 3): 50º 00' 54.98" Longitude: 125º 21' 12.96"

Method of drilling: [X] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [X] vertical [ ] horizontal Ground elevation: 599 ft (asl) Method (see note 4): GPS
Class of well (see note 5): Water supply Sub-class of well: Domestic
Water supply wells, indicate intended water use: [X] private domestic [ ] water supply system [ ] irrigation [ ] commercial or industrial [ ] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	170		brown		SAND & GRAVEL		
170	185		brown		sand		
185	240		brown		WATER-BEARING MEDIUM GRAINED SAND		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe
0	231.17	6	Steel	0.219	Yes

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
230.17		5	K-packer	
230.17	234.58	5	Screen	20
234.58	239	5	Screen	15

Production Casing Diameter: in
Surface seal: Type: Bentonite clay and cement mixtur Depth: 15 ft
Method of installation: [X] Poured [ ] Pumped Thickness: 1 in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [X] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [X] Telescope [ ] Pipe size
Screen material: [X] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [X] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [ ] Plug [ ] Plate [X] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[X] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: 5 hrs
Notes: WELL DEVELOPED BY AIR LIFTING & BAILING

Well yield estimated by:

[ ] Pumping [ ] Air lifting [X] Bailing [ ] Other (specify):
Rate: USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[X] Fresh [ ] Salty [X] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19): THOMAS WILLIAMS
Registration no. (see note 20): WD 06102703
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: 240 ft Finished well depth: 239 ft bgl
Final stick up: 30 in Depth to bedrock: ft bgl
SWL: 158 ft (btoc) Estimated well yield: 50.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: SIMPLE Well disinfected: [X] yes [ ] no
Where well ID plate is attached: TOP OF CASING

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 2010/08/18 Completed: 2010/08/20
Comment: SCREEN BOTTOM: BLANK. BAILED 10 GPM DREW 1'
- DRAWDOWN AVAILABLE 90'.

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

General

1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
2. The current Ministry standard datum for mapping and geodetic use is the North American Datum of 1983 (NAD 83). To determine GPS coordinates using a Global Positioning System (GPS), set the datum to NAD 83.
3. For latitude and longitude coordinates, provide coordinates either in degree, minutes and seconds (e.g., 50º 2¿ 21.037¿) or decimal degrees (e.g., 50.039175º).
4. For the method of determining ground elevation, enter: GPS, differential GPS, level, altimeter, 1:50,000 map, 1:20,000 map, 1:10,000 map or 1:5,000 map.
5. The classes and sub-classes of wells are shown below:

Class	Sub-class (if applicable)
Water supply	Domestic; Non-domestic
Monitoring	Temporary; Permanent
Recharge or injection	
Dewatering or drainage	Temporary; Permanent
Remediation	Temporary; Permanent
Geotechnical	Borehole; Test pit; Special type of hole; Closed loop geothermal

6. Well reports submitted to the Deputy Comptroller, or retained by the person responsible, as required under the Water Act and the Ground Water Protection Regulation, shall be considered part of the Provincial Government records and is subject to the Freedom of Information and Protection of Privacy Act.

How to Fill Out the Lithologic Description Table

7. Each row in the lithologic description table represents either a depth interval or depth in the well.
8. A row could represent a depth interval (e.g., from 0 feet to 12 feet), such as for a geologic stratum or a specific depth (e.g., 120 feet), such as for a depth location of a water-bearing fracture.
9. For a depth interval, enter the relative hardness of the material in the column ¿Relative Hardness," if applicable: Very Hard (VH), Hard (H), Dense (D), Stiff (ST), Medium (M), Loose (L), Soft (S), Very Soft (VS).
10. For a depth interval, enter the letter for the overall colour of the geologic material in the column "Colour," if applicable: White (W), Grey (Gy), Blue (Bl), Green (G), Yellow (Y), Brown (Br), Red (R), Tan (T), Black (Bk).
11. For each depth interval, enter the description of the geologic materials encountered during drilling in the column "Material Description.¿ Material descriptions should be chosen from the following recommended list of materials:

Surficial materials (approximate range of particle size)	**Bedrock materials**
boulders (greater than 10 inches)	conglomerate
cobbles (21/2 inches to 10 inches)	sandstone
gravel (80 slot to 21/2 inches)	shale
coarse sand (25 slot to 80 slot)	siltstone
medium sand (10 slot to 25 slot)	limestone
fine sand (2 slot to 10 slot)	crystalline
silt (less than 2 slot)	granite
clay (much less than 2 slot)	basalt
till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
13. Under the column "Water-bearing Estimated Flow (USgpm)," use "D" for "dry," "W" for "wet," or enter the estimated flow in USgpm.
14. If a water-bearing fracture is encountered, the depth of the fracture should be recorded in a row and the estimated flow of water in the fracture can be entered in the column "Water-bearing Estimated Flow (USgpm)."

How to Fill Out the Closure Description Table and the Well Closure Information Section

15. Each row in the closure description table represents either a depth interval (e.g., from 0 feet to 12 feet) or depth (e.g., 120 feet) in the well.
16. For a depth interval, enter the type of backfill or sealant material(s) in the column "Material Description."
17. Indicate in "Details of closure" whether casing(s) or screen(s) were pulled or left in place. If casing(s) were left in place, indicate whether it was perforated or ripped.

Screen Details

18. "Type" includes riser pipe, K-packer, screen, screen blank, or tail pipe.

Well Driller

19. Fill in the name of the driller who constructed the well.

Registration Number of Driller Responsible

20. Fill in the registration number on the Qualified Well Driller identification card. If the work was completed by a driller who is not registered as a Qualified Well Driller, the Qualified Well Driller who is directly supervising the work should fill in their registration number on their Qualified Well Driller identification card. The Qualified Well Driller signs the form.

Definitions of Abbreviations

asl .....above sea level
bgl .....below ground level
btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
ft .....feet
hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

BRITISH COLUMBIA
Ministry of Environment

[X] **Well Construction Report**
[ ] **Well Closure Report**
[ ] **Well Alteration Report**

Stamp company name/address/ phone/fax/email here, if desired.

Ministry Well ID Plate Number: 42401
Ministry Well Tag Number: 109728
Existing Well Tag Number:
[ ] Confirmation/alternative specs. attached
[ ] Original well construction report attached

Red lettering indicates minimum mandatory information **See reverse for notes & definitions of abbreviations.**

Owner Name: AL+SONS EXCAVATING
Mailing address: 1741-14TH AVENUE Town CAMPBELL RIVER Prov BC Postal Code V9W4H7
Well location: Street 6700 ARGONAUT ROAD Town CAMPBELL RIVER
(or) Legal description: Lot 85 Plan Block B Sec. Twp. Rg. Land District SAYWARD
(or) PID: (and) Description of well location (attach sketch, if nec.): NOTHING RECORDED

NAD 83:Zone: 10 (see note 2) (and) UTM Northing: 5542041 m UTM Easting: 331760 m (or) Latitude (see note 3): 50º 00' 24.88" Longitude: 125º 20' 52.69"

Method of drilling: [X] air rotary [ ] cable tool [ ] mud rotary [ ] auger [ ] driving [ ] jetting [ ] excavating [ ] other (specify):
Orientation of well: [X] vertical [ ] horizontal Ground elevation: 520 ft (asl) Method (see note 4): GPS
Class of well (see note 5): Water supply Sub-class of well: Domestic
Water supply wells, indicate intended water use: [X] private domestic [ ] water supply system [ ] irrigation [ ] commercial or industrial [ ] other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Description	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty wash), closure details
0	8	Medium	brown		GRAVEL AND SILTY SANDY		
8	14	Medium	brown		GRAVEL		ZONE WOOD
14	72	Medium	brown		GRAVEL, SANDY		LOOSE
72	110	Medium	brown		SAND,SILTY.		SILT LAYERS AND GRAVEL LAYERS
110	144	Medium	brown		SAND		CLEAN, LOOSE
144	156	Medium	brown		GRAVEL		WB,COARSE CLEAN
156	209	Medium	brown		SAND MED FINE		WB,CLEAN
209	216	Medium	brown		SAND,SILTY		WB,FINE

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material/Open Hole	Wall Thickness in	Drive Shoe
0	16	10	Steel Pulled Out		No
0	216	6	Steel	0.219	Yes

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
197	199	5	K-Packer & Riser	
199	203.6	5	Screen	15
203.6	208	5	Screen	12

Production Casing Diameter: 6 in
Surface seal: Type: Bentonite clay Depth: 16 ft
Method of installation: [X] Poured [ ] Pumped Thickness: 2 in
Backfill: Type: Depth: ft
Liner: [ ] PVC [ ] Other (specify):
Diameter: in Thickness: in
From: ft bgl To: ft bgl Perforated: From: ft bgl To: ft bgl

Intake: [X] Screen [ ] Open bottom [ ] Uncased hole
Screen type: [X] Telescope [ ] Pipe size
Screen material: [X] Stainless steel [ ] Plastic [ ] Other (specify):
Screen opening: [X] Continuous slot [ ] Slotted [ ] Perforated Pipe
Screen bottom: [ ] Bail [X] Plug [ ] Plate [ ] Other (specify):
Filter pack From: ft To: ft Thickness: in
Type and size of material:

Developed by:

[X] Air lifting [ ] Surging [ ] Jetting [ ] Pumping [ ] Bailing
[ ] Other (specify): Total duration: 3 hrs
Notes: BAILING AS WELL.

Well yield estimated by:

[ ] Pumping [X] Air lifting [ ] Bailing [ ] Other (specify):
Rate: 50 USgpm Duration: 2 hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

[X] Fresh [ ] Salty [X] Clear [ ] Cloudy [ ] Sediment [ ] Gas
Colour/odour: Water sample collected: [ ]

Well driller (print clearly):

Name (first, last) (see note 19): SCOTT BURROWS
Registration no. (see note 20): WD 04121407
Consultant (if applicable name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirenments in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible

Final well completion data:

Total depth drilled: 216 ft Finished well depth: 208 ft bgl
Final stick up: 20 in Depth to bedrock: ft bgl
SWL: 110 ft (btoc) Estimated well yield: 50.00 USgpm
Artesian flow: USgpm, or artesian pressure: ft
Type of well cap: WELDED LID Well disinfected: [X] yes [ ] no
Where well ID plate is attached: ON WELL CASING

Well closure information:

Reason for closure:
Method of closure:
Sealant material: Backfill material:
Details of closure:

Date of work (YYYY/MM/DD):

Started: 2015/01/14 Completed: 2015/01/15
Comment: EWELLS SUBMISSION

Please Note: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the work, which may change over time.

Well Owner Copy

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1. Requirements for well construction and well closure reports are found in Part 5 of the Water Act and the Ground Water Protection Regulation. Part 5 of the act and regulation are available at: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html.
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silt (less than 2 slot)	granite
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till (variable particle size)	volcanic
organics (e.g., top soil, wood, peat)	bedrock

12. In describing the material, list the material in order from greatest to least and indicate what materials occur in trace (less than 5%) amounts. The word "and" means both materials occur in approximately equal amounts (e.g., "gravel and coarse sand, trace silt").
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Registration Number of Driller Responsible

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btoc .....below top of casing
Dia .....Diameter
D.L. .....District Lot
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hrs .....hours
in .....inches
NAD 83 ...North American Datum (1983)
PID .....Parcel Identifier
Rg. .....Range
Sec. .....Section
SWL .....static water level
Twp. .....Township
USgpm ...US gallons per minute
UTM .....Universal Transverse Mercator Grid

updated: Feb. 7, 2006

Appendix D
Seismic Information

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

February 09, 2017

Site: 50.0082 N, 125.3488 W User File Reference: Campbell River Waste Management Centre

Requested by: Tim Morton,

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.321	0.505	**0.622**	0.641	**0.607**	**0.426**	**0.275**	**0.097**	**0.034**	**0.294**	**0.506**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.053	0.143	0.210
Sa(0.1)	0.080	0.223	0.332
Sa(0.2)	0.110	0.284	0.417
Sa(0.3)	0.114	0.291	0.429
Sa(0.5)	0.098	0.260	0.396
Sa(1.0)	0.060	0.170	0.269
Sa(2.0)	0.033	0.101	0.169
Sa(5.0)	0.0096	0.032	0.058
Sa(10.0)	0.0039	0.012	0.020
PGA	0.047	0.130	0.194
PGV	0.065	0.204	0.324

References

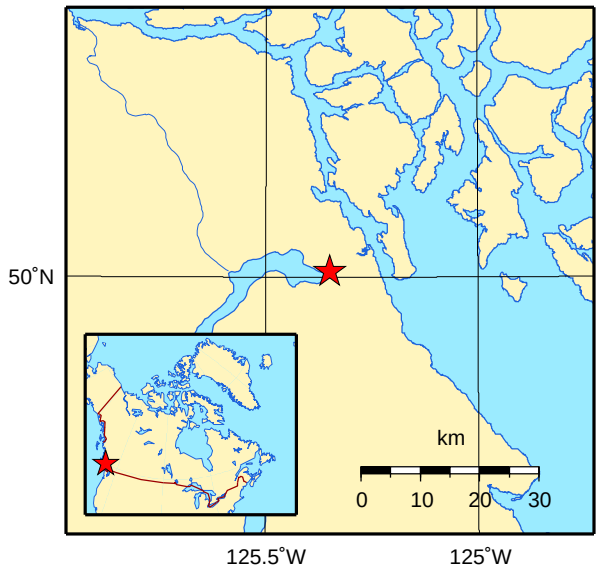
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: Tim Morton, February 09, 2017

Site Coordinates: 50.0082 North 125.3488 West

User File Reference: Campbell River Waste Management Centre

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.625	0.464	0.276	0.154	0.281

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.*** Warning: You are in a region which considers the hazard from a deterministic Cascadia subduction event for the National Building Code. Values determined for high probabilities (0.01 per annum) in this region do not consider the hazard from this type of earthquake.

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.148	0.317	0.436
Sa(0.5)	0.102	0.227	0.317
Sa(1.0)	0.057	0.130	0.185
Sa(2.0)	0.032	0.073	0.103
PGA	0.075	0.151	0.202

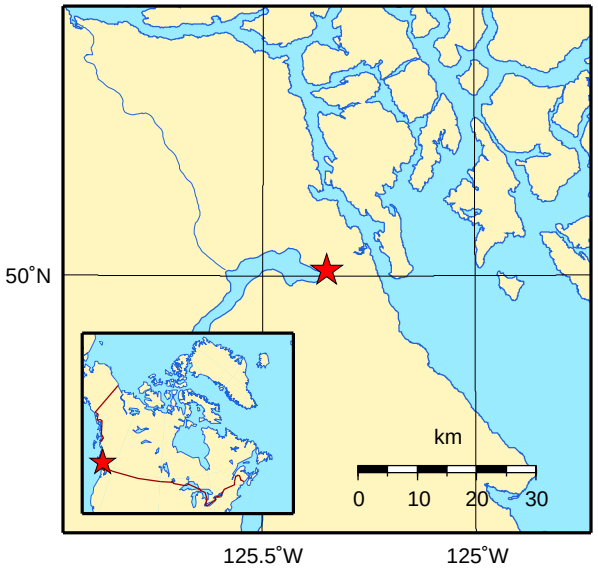
References

National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information



Aussi disponible en français

Appendix E
Conceptual Surface Water Management Plan (SWMP)

Memorandum

Draft for Review

November 14, 2017

To:	Comox Valley Regional District	Ref. No.:	056484
From:	David Hoover/cs/74	Tel:	604-214-0510
CC:	Deacon Liddy, Thomas Elliott, Paul Farquharson		
Subject:	**Campbell River Waste Management Centre Conceptual Surface Water Management Plan**		

1. Introduction

GHD Limited (GHD) has prepared this memorandum for Comox Strathcona Waste Management (CSWMC), a function of the Comox Valley Regional District (CVRD) to present a summary of design and analysis undertaken in support of the surface water management plan (SWMP) under development for the Campbell River Waste Management Centre (CRWMC or Site). The SWMP is being developed for inclusion in an updated Design, Operations, and Closure Plan (Updated DOCP) for the Site currently under development by GHD. The designs and analysis presented in this memorandum have been developed based on conceptual design drawings prepared for inclusion in the Updated DOCP and includes the following:

- Relevant site specific background information
- Surface water management plan (SWMP) design criteria
- Hydrologic characterization and assessment
- Recommendations and SWMP design features

2. Background and Site Description

The Site is located approximately 7.5 kilometers (km) east of the City of Campbell River, British Columbia (BC), on Argonaut Road, as illustrated on Figure 1. The elevation of site ranges from 132 metres above mean sea level (m AMSL) to 194 m AMSL.

The average annual precipitation measured at the nearby Environment Canada Campbell River Airport weather station (Station No. 1021261) is 1,489 millimetres (mm) per year according to Climate Normals from 1981-2010.

Surrounding regional geology is characterized by steeply diving igneous bedrock overlain by sand and gravel deposits. Areas that are overlain with sand and gravel typically demonstrate relatively high surface infiltration rates and have a relatively low runoff peak discharge during design storm events when compared to other soil types.

GHD is currently developing an updated DOCP for the Site including updated fill plan and contours which necessitate the development of revised surface water management infrastructure. Designs components contained in the Updated DOCP pertinent to the SWMP include the installation of a final cover system, the construction of a series of mid-slope and perimeter channels and the construction of the SWM Pond. Final cover will consist of a vegetated, a low permeability barrier system over the waste. Installation of the final cover system will result in increased surface water runoff when compared to pre-development conditions. Mid-slope and perimeter ditches will collect and convey surface runoff from the landfill and direct it to a SWM Pond. The SWM Pond will provide storage and infiltration capacity to attenuate discharge to the local receiving environment.

The pre-development conditions assume the Site was a forest with a 15% slopes. The pre-development condition establishes peak discharge design targets for the various design storm events, as further described below.

The post-development stormwater management system proposes to infiltrate a significant proportion of the runoff generated on the Site. The infiltration capacity and limits of the native soils will be confirmed in the field during the detailed design stage through the completion of test pits and infiltration testing (ASTM D3385) in the area of the proposed SWM Pond.

3. SWMP Objectives and Design Criteria

The designs developed in this memo have been prepared to meet regulatory guidelines contained in the Landfill Criteria for Municipal Solid Waste, second edition (Landfill Criteria) (BC Ministry of Environment, 2016) and to:

1. Ensure that the runoff/discharge associated with Site land use and operations will not adversely impact receiving waters downstream.
2. Ensure that surface water management channels and ponds provide sufficient capacity and durability to convey runoff from the contributing watershed through the Site in a manner that does not cause erosion or possible damage to the Site.

In order to meet the objectives, GHD undertook hydrologic modeling to assess the performance of the surface water management works under minor and major storm events and is to be completed for 5-, 10-, and 100-year design storm events. GHD combined modeling with the following criteria adapted from guidelines contained in the Landfill Criteria and best management practices (BMPs) to develop the designs:

A. In accordance with the Landfill Criteria surface water management infrastructure has been designed to meet the following criteria:

- Be designed to convey the discharge of a 1:100-year, 24-hour storm event
- Maintain a positive grade to prevent sedimentation and maintain hydraulic design capacity. Ditches shall be designed to accommodate localized settlement (no grade reversals)

- Be armored (rip rap, erosion control matting, or vegetative cover) to prevent erosion of ditch bottom and side slopes
- Make allowances for additional water that may result from snowmelt

B. In accordance with the BC Supplement to TAC (Transportation Association of Canada) Geometric Design Guide 2007 Edition (Tab 10-1000 Hydraulics Chapter) (BCMOT, 2007) surface water management channels shall have the following characteristics:

- The maximum allowable depth of flow is 0.6 m
- The recommended minimum freeboard is 0.3 m for small drainage channels. Due to the channel depth at this site being less than 0.9 m, GHD recommends a minimum freeboard depth of 0.15 m
- Typical channel side slopes range between 1.5:1 (H:V) to 4:1

C. In accordance with the Best Management Practices Guide Prepared for Greater Vancouver Sewerage and Drainage District (Allan Gibb, Harlan Kelly, and Thomas Schueler, 1999), the wet pond should meet the following criteria:

- Recommended maximum active storage depth is 2.0 m
- The maximum draining time is 48 hours
- Minimum length to width ratio of 3:1
- Maximum side slope of 3:1
- Minimum 300 mm free board

D. In accordance with the Best Management Practices Guide for Stormwater, Prepared for Greater Vancouver Sewerage and Drainage District (Allan Gibb, Harlan Kelly, and Thomas Schueler, 1999), the sediment forebay should meet the following criteria:

- Sedimentation forebay should provide 10% volume of permanent pool storage for wet pond
- Sedimentation forebay should provide 10% volume of total design storage volume for dry pond

E. In accordance with the Stormwater Management Planning and Design Manual (MOE Ontario, 2003), the forebay for the wet pond should meet the following criteria:

- Minimum length to width ratio is 3:1 for sediment forebay
- Minimum 1 m depth for sediment forebay

In addition, the stormwater management system will be designed to meeting the flowing criteria:

- The stormwater management system will be designed using the 24-hour, 5-year, 10-year and 100-year synthetic design storm with a Type 1A distribution.
- To account for frozen ground conditions and the landfill cap liner design, the sub-catchment parameters for depression storage and infiltration will be adjusted to be lower than would be typically considered for this type of soil and vegetative cover.

4. Hydrologic Assessment

4.1 Model Overview

A hydrologic assessment of the Site watershed was completed to provide estimates of the peak discharge that is expected to occur within the proposed channels. The hydrologic assessment was completed by developing a hydrologic model of the Site to estimate the runoff volume and discharge rate generated for post-development condition. The stormwater modeling for the Site was conducted using the software program PCSWMM 2017 developed by Computational Hydraulics International (CHI). PCSWMM uses the USEPA SWMM5 engine (currently version 5.1.011), and is a spatial decision support system for the USEPA SWMM5 program. The USEPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model that can be used for either single event or long-term (continuous) simulation of runoff quantity and quality.

PCSWMM allows modelling of runoff and conceptual design of drainage works such as piping network, open channel (rivers, creeks and ditches), weirs, dams, orifices, and storage/detention units. The computer model uses hydrologic and hydraulic methods to calculate and route hydrographs. The model requires input of a hyetograph, topographical features (catchment area, width, slope and hydraulic roughness), soil parameters, ground cover conditions (land use and vegetation cover) and drainage paths (channels, rivers, pipes and storage units).

4.2 Design Storms

The design of the stormwater management system is based upon the development of synthetic design storms that are developed using the return-period rainfall depths derived from the Campbell River Airport Intensity-Duration-Frequency (IDF) reports developed by Environment Canada. There are three Environment Canada weather stations in relatively close vicinity of the Site which generate IDF reports. They are Strathcona Dam (ID 1027775), Campbell River Airport weather station (Station No. 1021261), and Campbell River STP (ID 1021265). The location of these three weather stations are presented on Figure 2.

The Campbell River Airport station IDF report was selected based on the proximity to the project site, length of record and physiographic characteristics.

The Campbell River Airport IDF curve report is provided within Attachment A and is based upon 32 years of data (1970-2002). The station characteristics are provided below:

Table 4.1 Campbell River Airport Meteorological Station

Item	Attribute
Station Name	Campbell River Airport
Climate ID	1021261
Latitude	49 57'N
Longitude	125 16'W
Elevation	108 m
Period of Record	1970 – 2002

The Landfill final cover system, once installed, will have a lifespan in excess of 30 years. GHD accessed the Pacific Climate Impacts Consortium Plan2Adapt tool, on April 20, 2017, to consider climate change and the potential increase in rainfall depths in the future. The model results for the Strathcona Region are summarized in the table below and consider a 6% increase in annual rainfall in the future.

Table 4.2 Plan2Adapt tool estimated change in precipitation (2050)

Precipitation (%)	Annual	+6%	+2% to +12%
	Summer	-1%	-8% to +6%
	Winter	+8%	-2% to +15%

To account for the potential increase in rainfall depths as a result of climate change, the synthetic design storm rainfall depths are increased by 6%. Also, the IDF total rainfall depths were increased by 10% to compensate for the change in elevation between the Campbell River Airport and Site elevation. Therefore the synthetic design storms are based upon the IDF total rainfall depths with total increase of 16% over the IDF reported values.

Synthetic design storms were created for the 5-year, 10-year, and 100-year, 24 hour storm event using the Soil Conservation Service's Type 1A distribution which is appropriate for this geographic area. Rainfall parameters representing design storms are listed in the attached Table 1.

4.3 Hydrologic Model

The SWMP was developed for the full landfill closure condition. The landfill cover will be fully vegetated and consist of 150 millimetres (mm) of top soil over 600 mm sand over a geomembrane liner. The design of the SWMP plan features has assumed that there will be little to no storage capacity within the landfill cover system and the majority of rainfall will result in runoff from the landfill cover. This assumption would account for frozen ground conditions or antecedent wet moisture conditions. Therefore, the sub-catchment parameters for depression storage and infiltration will be adjusted to be lower than would be typically considered for this type of soil and vegetative cover which would have a greater infiltration capacity.

For analysis, the landfill cover system was divided into a series of catchments. The catchment boundary delineation is presented on Figure 3. Corresponding catchment model input parameters are summarized in Table 2A and Table 2B for the pre-development and post development condition. The pre-development condition was assumed to have been a forest with an approximate runoff volume coefficient of 20% during the 100-year event.

The model was developed to route runoff generated from each to a series of channels, which will convey runoff away from the landfill cover. A flow schematic, describing the SWM conveyance features (i.e. channels, ponds) and flow direction is presented in Figure 4.

4.4 SWM Pond Configuration

One SWM pond is proposed for the Site: The SWM Pond will store and infiltrate the surface runoff from the landfill and its adjacent areas to the north and west. The bottom elevation of the SWM ponds is 134.5 m AMSL.

The SWM pond will have 3:1 side slopes and a permanent pool depth of 1.0 m. The total available active storage volume from the pond is approximately 6,500 cubic meters (m^3) from the permanent pool elevation of the pond to the maximum ponding depth (top of pond). The volume of the SWM Pond will provide sufficient storage to contain and infiltrate the estimated runoff volume from the 1:100 year event. In the event of cumulative large rainfall events and outlet structure consisting of a 300 mm wide weir will discharge runoff from the pond to the roadside ditch via a 450 mm diameter culvert.

The bottom of the SWM Pond will be unlined to promote infiltration into the underlying soils. Existing borehole logs in the area of the SWM Pond indicates the bottom of the SWM pond will intercept a fine to medium grained sand (Wells EBA11-03 and EBA 11-04 as described in the 2013 Annual water Quality Monitoring Report, Tetra Tech, 2014). For the purposes of this SWM Plan an infiltration rate of 60 mm/hr has been assumed in the SWM Pond. The infiltration performance of the pond will be assessed during the detailed design stage by completing a field investigation consisting of test pits and infiltration testing. A stage-area table for pond configuration is included in Attachment B.

4.4.1 Sediment Forebay

A sediment forebay is proposed at the inlet of the SWM pond to preferentially settle large particulates in the sediment load within an area that can be conveniently accessed for maintenance. The forebay for the proposed infiltration pond was sized according to the design guidelines given in Section 3. Detailed calculations for the length and width for sediment forebay is provided in Attachment B.

An energy dissipation structure at the outlet of the steep channels is required to prevent erosion of natural channel bed and banks. A basin approximately 0.5 m deep that is 5 m wide and 10 m in length will be required to transition the discharge from super-critical to sub-critical flow. The basin will be lined with the concrete block lining similar to the channel lining.

4.5 Modelling Results

All hydrologic models were analyzed using synthetic design storms with return periods of 5-year, 10-year, 25-year and 100-year design storms.

Table 3A and 3B provides a summary of the estimated peak discharge rates from each catchment for the pre-development and post development condition.

Table 4A and 4B provides a summary of the estimated runoff volume from each catchment for the pre-development and post development condition. The model results indicate during the 100-year design storm that in excess of 90% of the rainfall results in runoff. Hydrologic model output files are provided in Attachment C.

The model also calculates the peak discharge within the channels. The channels were designed to convey the peak discharge from the 100-year design storm event. Some sections of the channel do not have the full 0.3 m of freeboard, but instead have a minimum freeboard of 0.21 m. No overtopping occurs at any locations and a minimum freeboard of 0.15 m is maintained, therefore the minimum freeboard of 0.23 m is acceptable. A summary of the channel characteristics and performance is provided in Table 5.

4.6 Perimeter Ditches and Culverts

The perimeter ditches around the landfill follow the overall surrounding land slope and grade. Some of the swales grade are relatively small (less than 2%) and some of the swales are higher (as much as 15%). High gradient ditches will require an engineered lining system to prevent erosion and scour. Also, a scour assessment at each culvert outlet will be required to determine the need to rip-rap apron protection or other energy dissipating measures. Table 5 also provides recommendations for the addition of erosion protection (i.e. turf reinforcement matting or ditch lining) for ditches with excessive grades resulting in a higher shear stress during periods of peak flow. Ditch lining is recommended for any ditch that would have an estimated shear stress in excess of 50 Pascal's (U.S. Soil Conservation Service Channel Design Handbook for Retardance Class C Vegetation) during the 100-Year event. Product Specifications for lining products are provided in Attachment D (equivalent products may be considered).

4.7 SWM Pond Perormance Summary

Table 6 provides a summary of the estimated ponding depths and storage volumes for the SWM Pond during the various design storms. The SWM Pond design calculations are included in Attachment B. The proposed SWM Pond will provide sufficient volume to infiltrate the runoff generated from the 25-year and 1-100 year design storms. The model indicates the SWM Pond will drain in less than the maximum limit for all storms (48-hours).

5. Conclusions and Recommendations

The surface water management infrastructure designs and analysis provided within this memo is conceptual and designed to satisfy the design criteria provided above. During the detailed design the following additional assessment will need to be completed:

- A surface water diversion berm is recommended north of the SWM pond to route surface runoff that does not need to be treated away from the SWM pond and landfill area.
- Energy dissipaters are recommended to address possible turbulence and erosion potential at ditch locations where the shear stress exceeds 40 Pascal's.
- The infiltration capacity of the pond will need to be assessed at the detailed design stage. A geotechnical investigation to characterize sub surface conditions and a double-ring infiltration tests (ASTM D3385-09) within the infiltration soil layer will be required.

6. References

Best Management Practices Guide Prepared for Greater Vancouver Sewerage and Drainage District (Allan Gibb, Harlan Kelly, and Thomas S, 1999),

BC Ministry of Environment, June 2016, Landfill Criteria for Municipal Solid Waste, Second Edition, British Columbia

BC Ministry of Transportation, 2007, Supplement to TAC (Transportation Association of Canada) Geometric Design Guide 2007 Edition

Campbell River Waste Management Centre, 2013 Annual Water Quality Monitoring Report, Comox Valley Regional District (Tetra Tech, April 30, 2014)

Computational Hydraulics Inc. (CHI) User's Guide to SWMM5, Guelph, Ontario, Canada

Computational Hydraulics Inc. (CHI). 2011. PCSWMM User's Manual, Guelph, Ontario, Canada



Source: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation, August 2011
Coordinate System: NAD 1983 UTM Zone 10N

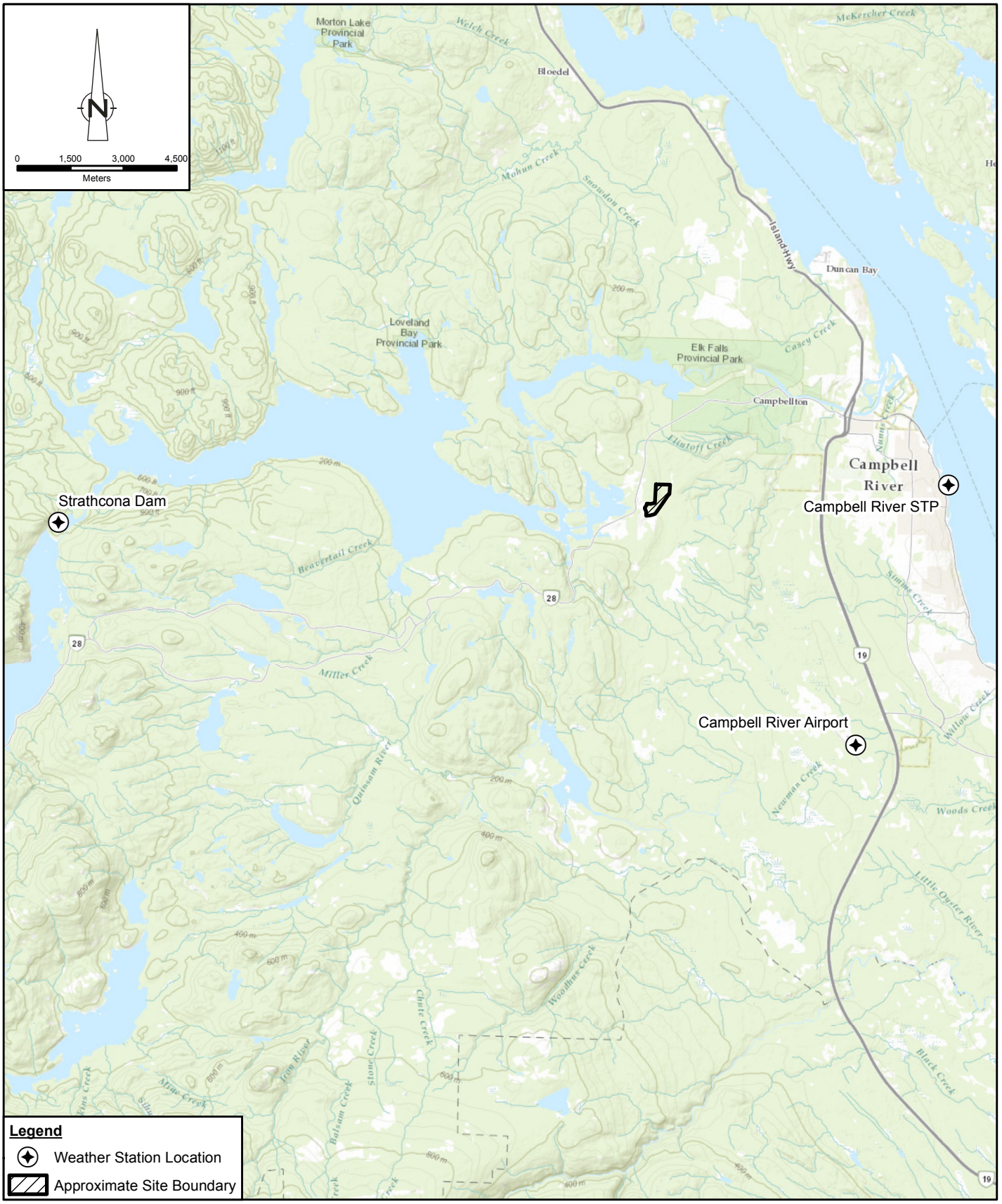
COMOX STRATHCONA WASTE MANAGEMENT
CAMPBELL RIVER WASTE MANAGEMENT CENTRE
CAMPBELL RIVER, BRITISH COLUMBIA

056484-200
Nov 14, 2017

KEY PLAN

FIGURE 1

GIS File: Q:\GIS\PROJECTS\56000s\56484\Layouts\PRES001\056484-200(PRES001)GIS-OT001.mxd



Source: ESRI Topographic Basemap, Accessed 2017
Coordinate System: NAD 1983 UTM Zone 10N

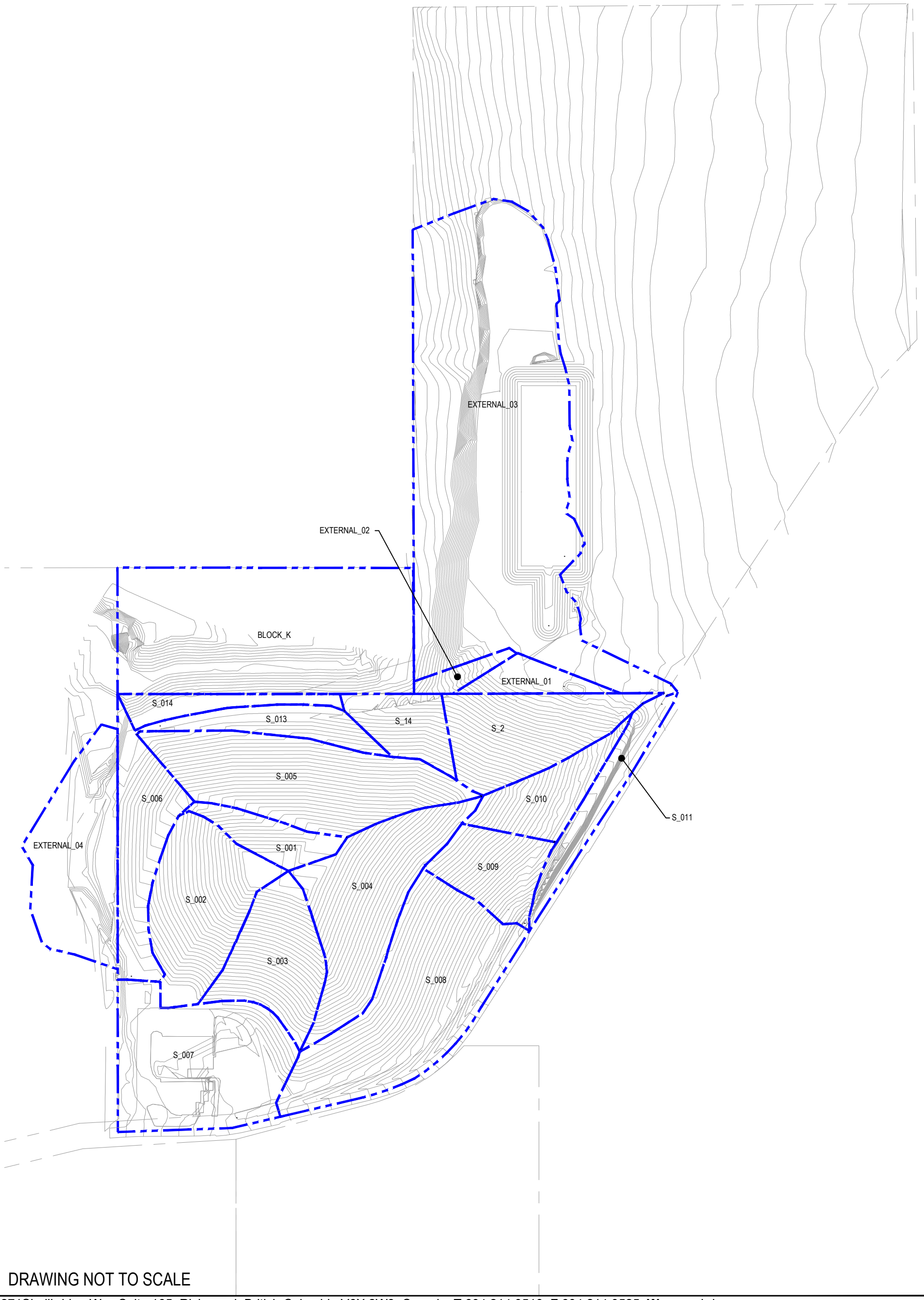
COMOX STRATHCONA WASTE MANAGEMENT
CAMPBELL RIVER WASTE MANAGEMENT CENTRE
CAMPBELL RIVER, BRITISH COLUMBIA

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WEATHER STATION LOCATIONS

FIGURE 2

GIS File: Q:\GIS\PROJECTS\56000s\56484\Layouts\PRES001\056484-200(PRES001)GIS-OT002.mxd



DRAWING NOT TO SCALE

10271Shellbridge Way Suite 165, Richmond, British Columbia V6X 2W8, Canada **T** 604 214 0510 **F** 604 214 0525 **W** www.ghd.com

COMOX STRATHCONA WASTE MANAGEMENT
CAMPBELL RIVER LANDFILL
BRITISH COLUMBIA

CATCHMENT BOUNDARY DELINEATION

LEGEND:

DRAINAGE BOUNDARY

056484

Nov 14, 2017

FIGURE 3

CAD File: P:\drawings\56000s\56484\56484-memo\56484-200(MEMO074)\56484-200(MEMO074)CI\056484-200(MEMO074)CI-WA001.dwg



DRAWING NOT TO SCALE

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COMOX STRATHCONA WASTE MANAGEMENT
CAMPBELL RIVER LANDFILL
BRITISH COLUMBIA

SWM CONVEYANCE FEATURES

LEGEND:

- DITCH
- CULVERT
- STORM PIPE
- ACCESS ROAD
- MANHOLE

056484

Nov 14, 2017

FIGURE 4

CAD File: P:\drawings\56000s\56484\56484-memo\56484-200(MEMO074)\56484-200(MEMO074)CI\056484-200(MEMO074)CI-WA001.dwg

Table 1

Design Storm Parameters
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Return Period	Type	Depth	Snowmelt Correction Factor	Climate Change Correction Factor	Rainfall Depth with Snowmelt and Climate Change Correction	Peak Intensity	Duration
		(mm)	(-)	(-)	(mm)	(mm/hr)	(hour)
5-year	SCS Type 1A	70.0	10%	6%	81.2	12.75	24
10-year	SCS Type 1A	77.7	10%	6%	90.1	14.15	24
25-year	SCS Type 1A	87.5	10%	6%	101.5	14.15	24
100-year	SCS Type 1A	101.9	10%	6%	118.2	18.56	24

Note:

1. 5-year, 10-year and 100-year design storm depths obtained from Environment Canada intensity-duration-frequency data for the Strathcona Dam (ID 1027775) IDF Station.

Table 2A

Pre-Development Conditions Catchment Parameters
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Catchment Parameters

Subcatchment ID	Area (ha)	Flow length (m)	Slope (%)	Imperviousness (%)	Manning' n		Depression Storage		Infiltration	
					Impervious (-)	Pervious (-)	Impervious (mm)	Pervious (mm)	Maximum (mm/hr)	Minimum (mm/hr)
Block_K	2.37	154	15	0	0.01	0.24	1.00	2.0	45	4.00
External_01	4.89	222	15	0	0.01	0.24	1.00	2.0	45	4.00
External_02	1.03	102	15	0	0.01	0.24	1.00	2.0	45	4.00
S_001	11.41	338	15	0	0.01	0.24	1.00	2.0	45	4.00
Total	19.71									

Table 2B

Post Development Conditions Catchment Parameters
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Catchment Parameters

Subcatchment ID	Area (ha)	Flow length (m)	Slope (%)	Imperviousness (%)	Manning' n		Depression Storage		Infiltration	
					Impervious (-)	Pervious (-)	Impervious (mm)	Pervious (mm)	Maximum (mm/hr)	Minimum (mm/hr)
Block_K	2.37	154	15	25	0.01	0.24	1.00	2.0	45	4.00
External_01	0.22	221	15	25	0.01	0.24	1.00	2.0	45	4.00
External_02	0.11	221	15	25	0.01	0.24	1.00	2.0	45	4.00
External_03	4.56	221	15	25	0.01	0.24	1.00	2.0	45	4.00
External_04	1.03	102	15	25	0.01	0.24	1.00	2.0	45	4.00
S_001	0.30	54	30	85	0.01	0.15	0.05	4.0	1	0.01
S_002	0.98	99	30	85	0.01	0.15	0.05	4.0	1	0.01
S_003	0.72	85	30	85	0.01	0.15	0.05	4.0	1	0.01
S_004	1.15	107	30	85	0.01	0.15	0.05	4.0	1	0.01
S_005	1.35	116	30	85	0.01	0.15	0.05	4.0	1	0.01
S_006	0.70	84	30	85	0.01	0.15	0.05	4.0	1	0.01
S_007	1.38	117	5	85	0.01	0.10	0.05	0.1	3	0.50
S_008	1.64	128	30	85	0.01	0.15	0.05	4.0	1	0.01
S_009	0.50	70	30	85	0.01	0.15	0.05	4.0	1	0.01
S_010	0.46	68	30	85	0.01	0.15	0.05	4.0	1	0.01
S_011	0.40	63	15	25	0.01	0.15	0.05	4.0	3	0.50
S_013	0.37	61	30	85	0.01	0.15	0.05	4.0	1	0.01
Total	18.24									

Pre-Development Conditions Peakflow Summary
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Peak Discharge Rates

Subcatchment ID	5-year (m^3/s)	10-year (m^3/s)	25-year (m^3/s)	100-year (m^3/s)
Block_K	0.04	0.05	0.07	0.09
External_01	0.21	0.28	0.38	0.53
External_02	0.02	0.03	0.03	0.04
S_001	0.15	0.19	0.25	0.36

Note:

1. Subcatchments "Block_K", "External_02" and "S_001" all run onto Subcatchment "External_01" prior to leaving the site.

Post Development Conditions Peakflow Summary
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Peak Discharge Rates

Subcatchment ID	5-year (m^3/s)	10-year (m^3/s)	25-year (m^3/s)	100-year (m^3/s)
Block_K	0.05	0.07	0.08	0.10
External_01	0.00	0.01	0.01	0.01
External_02	0.00	0.00	0.00	0.00
External_03	0.10	0.12	0.14	0.18
External_04	0.03	0.03	0.04	0.04
S_001	0.01	0.01	0.01	0.02
S_002	0.03	0.04	0.04	0.05
S_003	0.03	0.03	0.03	0.04
S_004	0.04	0.05	0.05	0.06
S_005	0.05	0.05	0.06	0.07
S_006	0.02	0.03	0.03	0.04
S_007	0.05	0.05	0.06	0.07
S_008	0.06	0.06	0.07	0.08
S_009	0.02	0.02	0.02	0.03
S_010	0.02	0.02	0.02	0.02
S_011	0.01	0.02	0.02	0.02
S_013	0.01	0.01	0.02	0.02

Table 4A

Pre-Development Conditions Runoff Volume Summary
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Runoff Volume

Subcatchment ID	5-year (m^3)	10-year (m^3)	25-year (m^3)	100-year (m^3)
Block_K	260	350	480	720
External_01	1940	2670	3820	5820
External_02	120	150	210	320
S_001	1240	1710	2430	3690

Note:

1. Subcatchments "Block_K", "External_02" and "S_001" all run onto Subcatchment "External_01" prior to leaving the site.

Table 4B

Post Development Conditions Runoff Volume Summary
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Runoff Volume

Subcatchment ID	5-year (m^3)	10-year (m^3)	25-year (m^3)	100-year (m^3)
Block_K	680	790	960	0
External_01	60	70	90	0
External_02	30	40	50	0
External_03	1290	1520	1840	0
External_04	300	350	420	0
S_001	240	270	300	0
S_002	790	870	990	0
S_003	580	650	730	0
S_004	920	1030	1160	0
S_005	1090	1210	1360	0
S_006	570	630	710	0
S_007	1090	1210	1370	0
S_008	1320	1470	1650	0
S_009	400	440	500	0
S_010	370	410	460	0
S_011	280	310	360	0
S_013	300	330	370	0

Table 5

Channel Performance Summary
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

Channel Characteristics & Performance Summary

Channel Section	Length (m)	Slope (m/m)	Cross-Section (-)	Depth / Diameter (m)	Number of Barrels	Bottom Width (m)	Left Side Slope (H:V)	Right Side Slope (H:V)	Drawdown (hr)	100-Year Storm					Recommended Channel Lining
										Max. Flowrate (m^3/s)	Max. Velocity (m/s)	Max. Depth (m)	Minimum Freeboard (m)	Max. Shear Stress (Pa)	
Ditches															
C_01	141	0.098	TRAPEZOIDAL	0.500	1	0.000	3.000	2.000	0.035	0.010	0.550	0.105	0.40	101	NA Green P550 TRM
C_02	138	0.102	TRAPEZOIDAL	0.500	1	0.000	3.000	2.000	0.035	0.030	0.960	0.280	0.22	279	FLEXMAT
C_03	140	0.020	TRAPEZOIDAL	0.500	1	0.000	2.000	3.000	0.035	0.100	0.530	0.320	0.18	62	NA Green P300 TRM
C_04	257	0.026	TRAPEZOIDAL	0.500	1	0.000	2.000	3.000	0.035	0.050	0.680	0.190	0.31	48	NA Green P300 TRM
C_05	284	0.041	TRAPEZOIDAL	0.500	1	0.000	3.000	2.000	0.035	0.050	1.130	0.315	0.19	128	NA Green P550 TRM
C_06	209	0.010	TRAPEZOIDAL	0.500	1	1.000	2.000	2.000	0.035	0.190	0.490	0.340	0.16	33	Vegetation, Unreinforced
C_07	257	0.075	TRAPEZOIDAL	0.500	1	1.000	2.000	2.000	0.035	0.040	0.520	0.290	0.21	215	FLEXMAT
C_09	68	0.185	TRAPEZOIDAL	0.500	1	0.000	2.000	3.000	0.035	0.010	1.590	0.285	0.22	518	FLEXMAT
C_10	112	0.089	TRAPEZOIDAL	0.500	1	0.000	3.000	2.000	0.035	0.010	1.610	0.075	0.43	65	NA Green P300 TRM
C_12	149	0.151	TRAPEZOIDAL	0.750	1	1.000	2.000	2.000	0.035	0.040	0.980	0.308	0.44	456	FLEXMAT
C_13	148	0.010	TRAPEZOIDAL	0.500	1	1.000	2.000	2.000	0.035	0.340	1.330	0.225	0.28	22	Vegetation, Unreinforced
C_14	3	0.009	TRAPEZOIDAL	0.600	1	1.800	2.000	2.000	0.035	0.120	0.380	0.486	0.11	44	NA Green P300 TRM
C_15	66	0.023	TRAPEZOIDAL	0.500	1	1.000	2.000	2.000	0.035	0.030	0.330	0.275	0.23	62	NA Green P300 TRM
C_16	12	0.210	TRAPEZOIDAL	0.500	1	1.000	2.000	2.000	0.035	0.000	0.020	0.240	0.26	495	FLEXMAT
C_INLET_01	15	0.048	TRAPEZOIDAL	0.500	1	2.000	2.000	2.000	0.035	0.160	1.760	0.180	0.32	84	NA Green P300 TRM
Culverts and Pipes															
CULVERT_01	215	0.015	CIRCULAR	0.525	1	0.000	0.000	0.000	0.022	0.650	1.200	0.420	0.00	N/A	CMP
CULVERT_02	23	0.013	CIRCULAR	0.525	1	0.000	0.000	0.000	0.022	0.560	1.290	0.315	0.00	N/A	CMP
CULVERT_03	17	0.010	CIRCULAR	0.675	1	0.000	0.000	0.000	0.013	0.370	1.500	0.405	0.00	N/A	CMP
CULVERT_04	34	0.009	CIRCULAR	0.600	2	0.000	0.000	0.000	0.013	0.440	1.760	0.330	0.00	N/A	CMP

Table 6

Surface Water Pond Performance Summary
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

North West SWM Pond

Design Storm	Pre-Development Release Rate (m^3/s)	Peak Inflow (m^3/s)	SWM Pond Release Rate (m^3/s)	Maximum Depth (m)	Maximum Elevation (AMSL m)	Maximum Storage (m^3)	Minimum Freeboard (m)
5-Year	0.21	0.58	0.00	0.54	135.04	3159.00	1.21
10-Year	0.28	0.66	0.00	0.65	135.15	3905.00	1.10
25-Year	0.38	0.77	0.00	0.81	135.31	4940.00	0.94
100-Year	0.53	0.92	0.00	1.05	135.55	6595.00	0.70

Attachment A
IDF Curve Reports

idf_CAMPBELL_RIVER_A
Environment Canada/Environnement 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

2012/02/09

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

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

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.	1.5	2.2	2.5	3.1	3.5	3.6	7.1	10.1	13.2

Écart-type 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

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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

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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%

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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

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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

idf_CAMPBELL_RIVER_STP
Environment Canada/Environnement 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

2014/12/21

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CAMPBELL RIVER STP BC 1021265
(composite)
Latitude: 50 1'N Longitude: 125 14'W Elevation/Altitude: 3 m

Years/Années : 1973 - 1995 # Years/Années : 14

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

****

Year / Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1973	-99.9	-99.9	-99.9	-99.9	9.9	16.5	28.4	40.1	57.1
1974	-99.9	-99.9	-99.9	-99.9	6.3	11.2	26.2	40.9	65.5
1975	-99.9	-99.9	-99.9	-99.9	14.0	18.5	37.6	40.4	59.7
1976	-99.9	-99.9	-99.9	-99.9	8.9	12.2	27.7	39.1	44.2
1977	-99.9	-99.9	-99.9	-99.9	23.9	30.0	38.4	51.3	71.4
1978	-99.9	-99.9	-99.9	-99.9	8.9	16.4	37.0	54.9	70.3
1979	-99.9	-99.9	-99.9	-99.9	23.0	25.2	31.5	47.9	77.3
1980	-99.9	-99.9	-99.9	-99.9	15.7	21.1	41.2	50.0	72.0
1981	-99.9	-99.9	-99.9	-99.9	18.2	18.3	31.0	42.1	62.2
1982	6.6	10.3	13.5	19.7	22.0	25.7	37.9	57.1	75.2
1983	2.4	3.5	4.1	7.8	14.9	26.5	35.3	51.1	79.5
1984	2.4	4.4	6.3	12.4	15.8	27.5	51.9	58.4	64.6
1985	3.1	3.1	3.9	5.6	8.1	13.7	22.8	33.2	39.7
1986	3.9	6.3	7.3	8.4	9.9	16.3	36.1	46.8	68.8
1987	4.2	5.6	5.8	8.9	12.1	14.5	35.6	44.4	58.8
1988	3.6	6.2	8.8	12.4	19.2	28.7	59.0	63.4	63.7
1989	5.7	8.0	9.2	9.5	10.8	10.8	18.2	26.7	39.2
1990	2.1	3.0	3.7	5.5	8.9	16.0	31.7	45.1	62.6
1991	4.4	5.6	6.2	7.1	7.9	15.8	42.6	58.8	66.2
1992	2.0	2.5	2.9	4.6	7.8	12.9	31.3	44.0	60.3
1993	10.7	11.6	12.5	13.5	14.8	17.2	27.5	46.1	61.8
1994	2.1	3.2	4.3	6.8	10.8	14.6	26.6	43.8	53.0
1995	2.4	3.6	5.5	8.0	10.9	16.2	33.7	50.1	65.8
# Yrs. / Années	14	14	14	14	23	23	23	23	23
Mean / Moyenne	4.0	5.5	6.7	9.3	13.2	18.5	34.3	46.8	62.6
Std. Dev. / Écart-type	2.4	2.8	3.3	4.0	5.2	5.9	9.0	8.5	10.7
Skew. / Dissymétrie	1.93	1.10	1.02	1.39	0.77	0.72	0.96	-0.17	-0.79
Kurtosis	7.51	3.97	3.82	5.69	2.87	2.60	5.09	3.64	3.78

*-99.9 Indicates Missing Data/Données manquantes

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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	5.7	7.1	8.9	10.2	11.5	14
10 min	5.0	7.5	9.2	11.2	12.8	14.3	14
15 min	6.2	9.1	11.0	13.4	15.1	16.9	14
30 min	8.6	12.2	14.6	17.5	19.8	21.9	14
1 h	12.3	16.9	19.9	23.8	26.6	29.5	23
2 h	17.5	22.7	26.2	30.5	33.7	36.9	23
6 h	32.8	40.8	46.0	52.6	57.5	62.4	23
12 h	45.4	52.9	57.9	64.2	68.9	73.6	23
24 h	60.8	70.3	76.5	84.4	90.3	96.1	23

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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	42.9	68.3	85.2	106.4	122.2	137.8	14
	+/- 13.8	+/- 23.3	+/- 31.4	+/- 42.4	+/- 50.7	+/- 59.1	14
10 min	30.2	45.1	55.0	67.4	76.7	85.9	14
	+/- 8.1	+/- 13.7	+/- 18.5	+/- 24.9	+/- 29.8	+/- 34.7	14
15 min	24.7	36.2	43.8	53.4	60.6	67.6	14
	+/- 6.3	+/- 10.5	+/- 14.2	+/- 19.2	+/- 22.9	+/- 26.7	14
30 min	17.3	24.4	29.1	35.1	39.5	43.9	14
	+/- 3.9	+/- 6.5	+/- 8.8	+/- 11.9	+/- 14.2	+/- 16.6	14
1 h	12.3	16.9	19.9	23.8	26.6	29.5	23
	+/- 1.9	+/- 3.3	+/- 4.4	+/- 6.0	+/- 7.2	+/- 8.3	23
2 h	8.8	11.4	13.1	15.2	16.9	18.5	23
	+/- 1.1	+/- 1.9	+/- 2.5	+/- 3.4	+/- 4.0	+/- 4.7	23
6 h	5.5	6.8	7.7	8.8	9.6	10.4	23
	+/- 0.6	+/- 0.9	+/- 1.3	+/- 1.7	+/- 2.1	+/- 2.4	23
12 h	3.8	4.4	4.8	5.4	5.7	6.1	23
	+/- 0.3	+/- 0.4	+/- 0.6	+/- 0.8	+/- 1.0	+/- 1.1	23
24 h	2.5	2.9	3.2	3.5	3.8	4.0	23
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.5	+/- 0.6	+/- 0.7	23

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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)

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Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans

idf_CAMPBELL_RIVER_STP						
Mean of RR/Moyenne de RR	16.4	24.0	29.1	35.4	40.2	44.9
Std. Dev. /Écart-type (RR)	13.7	22.1	27.6	34.6	39.8	44.9
Std. Error/Erreur-type	0.3	0.8	1.0	1.3	1.4	1.5
Coefficient (A)	12.5	17.1	20.0	23.7	26.4	29.1
Exponent/Exposant (B)	-0.491	-0.547	-0.571	-0.594	-0.606	-0.617
Mean % Error/% erreur moyenne	1.9	2.1	2.1	2.3	2.4	2.6

idf_STRATHCONA_DAM
Environment Canada/Environnement 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

2014/12/21

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STRATHCONA DAM BC 1027775

Latitude: 50 0'N Longitude: 125 35'W Elevation/Altitude: 201 m

Years/Années : 1968 - 1982 # Years/Années : 14

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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
1968	-99.9	-99.9	-99.9	-99.9	12.7	20.3	56.4	100.6	154.9
1969	-99.9	-99.9	-99.9	-99.9	24.4	25.1	32.3	49.5	58.4
1970	-99.9	-99.9	-99.9	-99.9	6.1	10.9	24.1	32.5	37.3
1972	-99.9	-99.9	-99.9	-99.9	8.1	11.4	24.6	30.5	39.4
1973	-99.9	-99.9	-99.9	-99.9	25.4	27.9	34.5	44.4	56.6
1974	-99.9	-99.9	-99.9	-99.9	8.1	16.0	30.5	43.7	68.8
1975	-99.9	-99.9	-99.9	-99.9	9.1	16.0	26.7	43.2	66.8
1976	-99.9	-99.9	-99.9	-99.9	7.1	11.7	26.7	36.8	45.0
1977	-99.9	-99.9	-99.9	-99.9	9.1	14.2	31.5	51.1	59.2
1978	-99.9	-99.9	-99.9	-99.9	14.0	19.1	38.1	42.9	66.8
1979	-99.9	-99.9	-99.9	-99.9	15.2	16.8	37.6	49.8	64.5
1980	-99.9	-99.9	-99.9	-99.9	12.0	20.8	36.8	63.4	101.2
1981	-99.9	-99.9	-99.9	-99.9	13.2	16.6	29.2	41.2	60.2
1982	-99.9	-99.9	-99.9	-99.9	18.8	25.4	29.6	41.4	52.8
# Yrs. / Années	0	0	0	0	14	14	14	14	14
Mean / Moyenne	-99.9	-99.9	-99.9	-99.9	13.1	18.0	32.8	47.9	66.6
Std. Dev. / Écart-type	-99.9	-99.9	-99.9	-99.9	6.1	5.4	8.2	17.2	29.8
Skew. / Dissymétrie	-99.90	-99.90	-99.90	-99.90	1.01	0.45	1.92	2.43	2.28
Kurtosis	-99.90	-99.90	-99.90	-99.90	3.76	2.91	8.25	10.26	9.29

*-99.9 Indicates Missing Data/Données manquantes

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

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idf_STRATHCONA_DAM

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
10 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
15 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
30 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
1 h	12.1	17.5	21.1	25.6	28.9	32.3	14
2 h	17.1	21.9	25.0	29.0	32.0	34.9	14
6 h	31.4	38.7	43.5	49.5	54.0	58.5	14
12 h	45.1	60.3	70.4	83.2	92.6	102.0	14
24 h	61.7	88.0	105.4	127.4	143.7	159.9	14

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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	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
10 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
15 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
30 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
1 h	12.1	17.5	21.1	25.6	28.9	32.3	14
	+/- 2.9	+/- 4.9	+/- 6.7	+/- 9.0	+/- 10.8	+/- 12.6	14
2 h	8.6	10.9	12.5	14.5	16.0	17.5	14
	+/- 1.3	+/- 2.2	+/- 2.9	+/- 4.0	+/- 4.8	+/- 5.5	14
6 h	5.2	6.4	7.2	8.3	9.0	9.7	14
	+/- 0.7	+/- 1.1	+/- 1.5	+/- 2.0	+/- 2.4	+/- 2.8	14
12 h	3.8	5.0	5.9	6.9	7.7	8.5	14
	+/- 0.7	+/- 1.2	+/- 1.6	+/- 2.1	+/- 2.5	+/- 3.0	14
24 h	2.6	3.7	4.4	5.3	6.0	6.7	14
	+/- 0.6	+/- 1.0	+/- 1.4	+/- 1.8	+/- 2.2	+/- 2.5	14

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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	6.4	8.7	10.2	12.1	13.5	14.9
Std. Dev. /Écart-type (RR)	3.9	5.6	6.8	8.3	9.4	10.5
Std. Error/Erreur-type	0.1	0.9	1.4	2.2	2.7	3.3
Coefficient (A)	12.1	16.2	19.0	22.4	24.9	27.4
Exponent/Exposant (B)	-0.480	-0.480	-0.479	-0.479	-0.479	-0.479
Mean % Error/% erreur moyenne	1.7	5.1	7.5	9.6	10.8	11.8

Attachment B
Design Calculations

Design Calculations - Forebay Desgin
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

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

Infiltration Basin Volume=	10228	m^3
Sediment Forebay Volume=	10% of Infiltration Basin Volume	
Sediment Forebay Volume=	1023	m^3
Forebay Length to width ratio=	2:1	
Forebay Depth=	1	m
Forebay Length=	45	m
Forebay Width=	23	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

Design Calculations - Infiltration Pond
Comox Strathcona Waste Management
Campbell River Solid Waste Management Centre
Campbell River, British Columbia

SWM Pond
Stage/Storage Relationship

Elevation		Area		Depth		Total Storage	
(m)	(ft)	(m^2)	(ft^2)	(m)	(ft)	(m^3)	(ft^3)
133.75	438.8	2413	25975	0			
133.95	439.5	2654	28572	0.2	0.7	507	17896
134.15	440.1	2920	31430	0.4	1.3	1067	37667
134.35	440.8	3212	34573	0.6	2.0	1688	59594
134.55	441.4	3533	38030	0.8	2.6	2378	83996
134.75	442.1	3886	41833	1	3.3	3150	111233
134.95	442.7	4275	46016	1.2	3.9	4013	141715
135.15	443.4	4703	50618	1.4	4.6	4981	175902
135.35	444.1	5173	55680	1.6	5.2	6069	214316
135.55	444.7	5690	61248	1.8	5.9	7293	257547
135.75	445.4	6259	67372	2	6.6	8672	306257
135.95	446.0	6885	74110	2.2	7.2	10228	361197

Note:

* Volume for an interval calculated by Average End Area Method.

0	2413
0.2	2654
0.4	2920
0.6	3212
0.8	3533
1	3886
1.2	4275
1.4	4703
1.6	5173
1.8	5690
2	6259
2.2	6885

Attachment C
Hydrologic Model Output Files

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)

This model will show the existing and proposed scenario(s) for the Campbell River Landfill project.

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 20
Number of nodes 27
Number of links 26
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_24h_Type_IA_118.2mm	100yr_SCS_24h_Type_IA_118.2mm	VOLUME	15 min.
10yr_SCS_24h_Type_IA_90.1mm	10yr_SCS_24h_Type_IA_90.1mm	VOLUME	15 min.
25yr_SCS_24h_Type_IA_101.5mm	25yr_SCS_24h_Type_IA_101.5mm	VOLUME	15 min.
5yr_SCS_24h_Type_IA_81.2mm	5yr_SCS_24h_Type_IA_81.2mm	VOLUME	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
Block_K	2.37	153.95	25.00	15.0000	5yr_SCS_24h_Type_IA_81.2mm	S_014
External_01	0.22	9.74	25.00	15.0000	5yr_SCS_24h_Type_IA_81.2mm	D_001
External_02	0.11	5.19	25.00	15.0000	5yr_SCS_24h_Type_IA_81.2mm	D_002
External_03	4.56	206.11	25.00	15.0000	5yr_SCS_24h_Type_IA_81.2mm	SW_Pond
External_04	1.03	101.66	25.00	15.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C006
S_001	0.30	54.46	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C011
S_002	0.98	98.93	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C010
S_003	0.72	85.11	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C008
S_004	1.15	107.14	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C009
S_005	1.35	116.27	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C012
S_006	0.70	83.93	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C006
S_007	1.38	117.36	85.00	5.0000	5yr_SCS_24h_Type_IA_81.2mm	D_B004
S_008	1.64	128.15	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_B004
S_009	0.50	70.42	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_B005
S_010	0.46	67.93	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_A004
S_011	0.40	63.45	25.00	15.0000	5yr_SCS_24h_Type_IA_81.2mm	D_B003
S_013	0.37	60.80	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C003
S_014	0.24	49.19	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C003
S_14	0.37	33.58	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_C002
S_2	0.85	77.08	85.00	30.0000	5yr_SCS_24h_Type_IA_81.2mm	D_001

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow

Control_MH	JUNCTION	134.25	2.00	0.0
D_001	JUNCTION	138.00	0.50	0.0
D_002	JUNCTION	139.00	0.50	0.0
D_A001	JUNCTION	136.77	1.00	0.0
D_A003	JUNCTION	142.34	1.00	0.0
D_A004	JUNCTION	152.22	0.50	0.0
D_B001	JUNCTION	136.77	1.00	0.0
D_B003	JUNCTION	139.89	0.53	0.0
D_B004	JUNCTION	159.26	0.50	0.0
D_B005	JUNCTION	152.22	0.50	0.0
D_C001	JUNCTION	136.50	1.00	0.0
D_C002	JUNCTION	158.72	0.50	0.0
D_C003	JUNCTION	160.20	1.00	0.0
D_C004	JUNCTION	160.37	1.00	0.0
D_C005	JUNCTION	160.40	0.60	0.0
D_C006	JUNCTION	162.48	1.00	0.0
D_C007	JUNCTION	162.78	1.00	0.0
D_C008	JUNCTION	165.53	0.50	0.0
D_C009	JUNCTION	172.12	0.50	0.0
D_C010	JUNCTION	176.75	0.50	0.0
D_C011	JUNCTION	190.50	0.50	0.0
D_C012	JUNCTION	172.12	0.50	0.0
DO_001	JUNCTION	136.20	1.00	0.0
DO_002	JUNCTION	136.73	1.00	0.0
J1	JUNCTION	137.01	1.61	0.0
OF1	OUTFALL	132.25	0.45	0.0
SW_Pond	STORAGE	134.50	1.75	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C_01	D_C011	D_C010	CONDUIT	141.4	9.7712	0.0350
C_02	D_C010	D_C007	CONDUIT	138.1	10.1710	0.0350
C_03	D_C008	D_C007	CONDUIT	139.9	1.9664	0.0350
C_04	D_C009	D_C008	CONDUIT	256.6	2.5686	0.0350
C_05	D_C012	D_C005	CONDUIT	283.7	4.1351	0.0350
C_06	D_C006	D_C005	CONDUIT	208.5	0.9975	0.0350
C_07	D_B004	D_B003	CONDUIT	257.5	7.5440	0.0350
C_09	D_B005	D_B003	CONDUIT	67.7	18.5197	0.0350
C_10	D_A004	D_A003	CONDUIT	111.7	8.8767	0.0350
C_12	D_C002	D_C001	CONDUIT	148.6	15.1229	0.0350
C_13	D_C003	D_C002	CONDUIT	148.1	0.9995	0.0350
C_14	D_C005	D_C004	CONDUIT	3.2	0.9288	0.0350
C_15	D_001	D_C001	CONDUIT	65.7	2.2827	0.0350
C_16	D_002	D_C001	CONDUIT	12.1	21.0260	0.0350
C_INLET_01	DO_001	SW_Pond	CONDUIT	14.8	4.7511	0.0350
CULVERT_01	D_B003	D_B001	CONDUIT	214.7	1.4531	0.0220
CULVERT_02	D_C007	D_C006	CONDUIT	23.2	1.2915	0.0220
CULVERT_03	D_C004	D_C003	CONDUIT	16.8	1.0102	0.0130
CULVERT_04	D_C001	DO_001	CONDUIT	34.0	0.8824	0.0130
OUTLET_01	Control_MH	OF1	CONDUIT	200.0	1.0001	0.0130
STM_01	D_A003	J1	CONDUIT	19.1	29.0176	0.0130
STM_02	J1	D_A001	CONDUIT	18.8	1.2767	0.0130
STM_03	D_A001	DO_002	CONDUIT	5.8	0.5190	0.0100
STM_04	D_B001	DO_002	CONDUIT	6.0	0.6645	0.0100
STM_05	DO_002	DO_001	CONDUIT	108.8	0.4873	0.0130
W1	SW_Pond	Control_MH	WEIR			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C_01	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.11
C_02	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.15
C_03	TRAPEZOIDAL	0.50	1.12	0.30	3.50	1	2.04
C_04	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.08
C_05	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.37
C_06	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.30
C_07	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	3.59
C_09	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.90
C_10	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.01
C_12	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.08
C_13	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.31
C_14	TRAPEZOIDAL	0.60	1.80	0.40	4.20	1	2.70
C_15	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.97
C_16	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.99
C_INLET_01	TRAPEZOIDAL	0.50	1.50	0.35	4.00	1	4.68
CULVERT_01	CIRCULAR	0.53	0.22	0.13	0.53	1	0.31
CULVERT_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.29
CULVERT_03	RECT_CLOSED	0.90	1.62	0.30	1.80	1	5.61
CULVERT_04	RECT_CLOSED	0.90	1.62	0.30	1.80	2	5.25
OUTLET_01	CIRCULAR	0.45	0.16	0.11	0.45	1	0.29
STM_01	CIRCULAR	0.25	0.05	0.06	0.25	1	0.32
STM_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.49
STM_03	CIRCULAR	0.53	0.22	0.13	0.53	1	0.40
STM_04	CIRCULAR	0.53	0.22	0.13	0.53	1	0.46
STM_05	CIRCULAR	0.53	0.22	0.13	0.53	1	0.30

****
Transect Summary
****

Transect v-ditch_01
Area:

0.0004	0.0016	0.0036	0.0064	0.0100
0.0144	0.0196	0.0256	0.0324	0.0400
0.0484	0.0576	0.0676	0.0784	0.0900
0.1024	0.1156	0.1296	0.1444	0.1600
0.1764	0.1936	0.2116	0.2304	0.2500
0.2704	0.2916	0.3136	0.3364	0.3600
0.3844	0.4096	0.4356	0.4624	0.4900
0.5184	0.5476	0.5776	0.6084	0.6400
0.6724	0.7056	0.7396	0.7744	0.8100
0.8464	0.8836	0.9216	0.9604	1.0000

Hrad:

0.0200	0.0400	0.0600	0.0800	0.1000
0.1200	0.1400	0.1600	0.1800	0.2000
0.2200	0.2400	0.2600	0.2800	0.3000
0.3200	0.3400	0.3600	0.3800	0.4000
0.4200	0.4400	0.4600	0.4800	0.5000
0.5200	0.5400	0.5600	0.5800	0.6000
0.6200	0.6400	0.6600	0.6800	0.7000
0.7200	0.7400	0.7600	0.7800	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

Width:

0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_01(orig)
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_02
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000

0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

****
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 02/14/2017 00:00:00
Ending Date 02/16/2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:15
Wet Time Step 00:00:05
Dry Time Step 00:00:15
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 4
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	1.600	81.206
Evaporation Loss	0.000	0.000
Infiltration Loss	0.445	22.572
Surface Runoff	1.148	58.254
Final Storage	0.007	0.380
Continuity Error (%)	0.000	

**********	Volume	Volume
Flow Routing Continuity	hectare-m	10^6 ltr
**********	---	---
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.148	11.481
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	1.148	11.481
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.000	

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
Link CULVERT_02 (12)
Link CULVERT_01 (5)

****
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
Block_K	81.21	0.00	0.00	52.47	28.55	0.68	0.05	0.352
External_01	81.21	0.00	0.00	52.72	28.30	0.06	0.00	0.348
External_02	81.21	0.00	0.00	52.72	28.30	0.03	0.00	0.348
External_03	81.21	0.00	0.00	52.72	28.30	1.29	0.10	0.348
External_04	81.21	0.00	0.00	52.27	28.75	0.30	0.03	0.354
S_001	81.21	0.00	0.00	0.11	80.49	0.24	0.01	0.991
S_002	81.21	0.00	0.00	0.11	80.49	0.79	0.03	0.991
S_003	81.21	0.00	0.00	0.11	80.49	0.58	0.03	0.991
S_004	81.21	0.00	0.00	0.11	80.49	0.92	0.04	0.991
S_005	81.21	0.00	0.00	0.11	80.49	1.09	0.05	0.991

S_006	81.21	0.00	0.00	0.11	80.49	0.57	0.02	0.991
S_007	81.21	0.00	0.00	1.94	79.23	1.09	0.05	0.976
S_008	81.21	0.00	0.00	0.11	80.48	1.32	0.06	0.991
S_009	81.21	0.00	0.00	0.11	80.49	0.40	0.02	0.991
S_010	81.21	0.00	0.00	0.11	80.49	0.37	0.02	0.991
S_011	81.21	0.00	0.00	12.81	68.38	0.28	0.01	0.842
S_013	81.21	0.00	0.00	0.11	80.49	0.30	0.01	0.991
S_014	81.21	279.57	0.00	0.11	360.06	0.87	0.06	0.998
S_14	81.21	0.00	0.00	0.11	80.49	0.30	0.01	0.991
S_2	81.21	0.00	0.00	0.11	80.49	0.69	0.03	0.991

****
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
Control_MH	JUNCTION	0.00	0.00	134.25	0 00:00	0.00
D_001	JUNCTION	0.01	0.05	138.05	0 08:00	0.05
D_002	JUNCTION	0.00	0.01	139.01	0 08:00	0.01
D_A001	JUNCTION	0.05	0.27	137.04	0 07:33	0.27
D_A003	JUNCTION	0.01	0.04	142.38	0 08:00	0.04
D_A004	JUNCTION	0.03	0.09	152.31	0 08:00	0.09
D_B001	JUNCTION	0.06	0.27	137.04	0 07:35	0.27
D_B003	JUNCTION	0.08	0.34	140.23	0 08:00	0.34
D_B004	JUNCTION	0.02	0.07	159.33	0 08:00	0.07
D_B005	JUNCTION	0.02	0.07	152.29	0 08:00	0.07
D_C001	JUNCTION	0.03	0.16	136.66	0 08:00	0.16
D_C002	JUNCTION	0.02	0.11	158.83	0 08:00	0.11
D_C003	JUNCTION	0.06	0.25	160.45	0 08:00	0.25
D_C004	JUNCTION	0.04	0.19	160.56	0 08:00	0.19
D_C005	JUNCTION	0.03	0.17	160.57	0 08:00	0.17
D_C006	JUNCTION	0.04	0.17	162.65	0 08:00	0.17
D_C007	JUNCTION	0.07	0.29	163.07	0 08:00	0.29
D_C008	JUNCTION	0.02	0.08	165.61	0 08:00	0.08
D_C009	JUNCTION	0.05	0.16	172.28	0 08:00	0.16
D_C010	JUNCTION	0.04	0.12	176.87	0 08:00	0.12
D_C011	JUNCTION	0.02	0.07	190.57	0 08:00	0.07
D_C012	JUNCTION	0.05	0.15	172.27	0 07:11	0.15
DO_001	JUNCTION	0.03	0.14	136.34	0 08:00	0.14
DO_002	JUNCTION	0.08	0.31	137.04	0 07:34	0.31
J1	JUNCTION	0.02	0.07	137.08	0 08:00	0.07
OF1	OUTFALL	0.00	0.00	132.25	0 00:00	0.00
SW_Pond	STORAGE	0.17	0.54	135.04	0 11:17	0.54

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Node Inflow Summary
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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
Control_MH	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
D_001	JUNCTION	0.035	0.035	0 08:00	0.747	0.747	-0.007

D_002	JUNCTION	0.002	0.002	0	08:00	0.0325	0.0325	-0.001
D_A001	JUNCTION	0.000	0.016	0	08:00	0	0.424	0.083
D_A003	JUNCTION	0.000	0.016	0	08:00	0	0.371	0.003
D_A004	JUNCTION	0.016	0.016	0	08:00	0.371	0.371	-0.001
D_B001	JUNCTION	0.000	0.150	0	07:57	0	3.08	-0.132
D_B003	JUNCTION	0.014	0.138	0	08:00	0.275	3.09	0.165
D_B004	JUNCTION	0.107	0.107	0	08:00	2.41	2.41	-0.028
D_B005	JUNCTION	0.018	0.018	0	08:00	0.399	0.399	-0.064
D_C001	JUNCTION	0.000	0.334	0	08:00	0	6.73	0.001
D_C002	JUNCTION	0.013	0.297	0	08:00	0.299	5.95	0.000
D_C003	JUNCTION	0.076	0.285	0	08:00	1.17	5.65	0.000
D_C004	JUNCTION	0.000	0.209	0	08:00	0	4.49	0.000
D_C005	JUNCTION	0.000	0.210	0	08:00	0	4.49	0.018
D_C006	JUNCTION	0.051	0.162	0	08:00	0.864	3.39	-0.160
D_C007	JUNCTION	0.000	0.111	0	08:00	0	2.53	0.253
D_C008	JUNCTION	0.026	0.066	0	08:00	0.583	1.51	-0.018
D_C009	JUNCTION	0.041	0.041	0	08:00	0.924	0.924	-0.008
D_C010	JUNCTION	0.035	0.045	0	08:00	0.788	1.03	-0.058
D_C011	JUNCTION	0.011	0.011	0	08:00	0.239	0.239	-0.013
D_C012	JUNCTION	0.048	0.048	0	08:00	1.09	1.09	-0.067
DO_001	JUNCTION	0.000	0.488	0	08:00	0	10.2	0.001
DO_002	JUNCTION	0.000	0.156	0	07:33	0	3.51	-0.011
J1	JUNCTION	0.000	0.016	0	08:00	0	0.371	-0.004
OF1	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
SW_Pond	STORAGE	0.095	0.582	0	08:00	1.29	11.5	-0.000

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Node Surcharge Summary
****

No nodes were surcharged.

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Node Flooding Summary
****

No nodes were flooded.

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Storage Volume Summary
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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
SW_Pond	0.986	8	0	100	3.159	27	0 11:17	0.141

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr

OF1	0.00	0.000	0.000	0.000
System	0.00	0.000	0.000	0.000

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Link Flow Summary
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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C_01	CONDUIT	0.011	0	08:00	0.50	0.00	0.19
C_02	CONDUIT	0.045	0	08:00	1.30	0.02	0.41
C_03	CONDUIT	0.066	0	08:00	0.29	0.03	0.37
C_04	CONDUIT	0.041	0	08:00	1.10	0.04	0.24
C_05	CONDUIT	0.049	0	07:18	1.09	0.04	0.31
C_06	CONDUIT	0.162	0	08:00	0.71	0.12	0.34
C_07	CONDUIT	0.107	0	08:00	0.49	0.03	0.42
C_09	CONDUIT	0.018	0	08:00	1.46	0.01	0.42
C_10	CONDUIT	0.016	0	08:00	1.50	0.01	0.13
C_12	CONDUIT	0.297	0	08:00	1.71	0.06	0.27
C_13	CONDUIT	0.284	0	08:00	1.15	0.22	0.36
C_14	CONDUIT	0.209	0	08:00	0.53	0.08	0.30
C_15	CONDUIT	0.035	0	08:00	0.36	0.02	0.22
C_16	CONDUIT	0.002	0	08:00	0.03	0.00	0.17
C_INLET_01	CONDUIT	0.488	0	08:00	1.53	0.10	0.28
CULVERT_01	CONDUIT	0.150	0	07:57	1.16	0.49	0.58
CULVERT_02	CONDUIT	0.111	0	08:00	1.32	0.39	0.43
CULVERT_03	CONDUIT	0.209	0	08:00	0.53	0.04	0.25
CULVERT_04	CONDUIT	0.333	0	08:00	0.61	0.03	0.17
OUTLET_01	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
STM_01	CONDUIT	0.016	0	08:00	2.54	0.05	0.19
STM_02	CONDUIT	0.016	0	08:00	0.53	0.03	0.32
STM_03	CONDUIT	0.021	0	07:15	0.49	0.05	0.54
STM_04	CONDUIT	0.138	0	07:38	1.15	0.30	0.55
STM_05	CONDUIT	0.154	0	07:47	1.77	0.51	0.43
W1	WEIR	0.000	0	00:00		0.00	

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Flow Classification Summary
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Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Up Dry	Down Dry	Sub Dry	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C_01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_02	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_03	1.00	0.00	0.05	0.00	0.95	0.00	0.00	1.00	0.00
C_04	1.00	0.00	0.00	0.00	0.37	0.63	0.00	0.00	0.00
C_05	1.00	0.00	0.00	0.00	0.44	0.56	0.00	0.17	0.00
C_06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.50	0.00
C_07	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_09	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_10	1.00	0.00	0.00	0.00	0.42	0.58	0.00	0.00	0.00
C_12	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.50	0.00
C_13	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00

C_14	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.30	0.00
C_15	1.00	0.00	0.11	0.00	0.88	0.00	0.00	0.00	0.99	0.00
C_16	1.00	0.00	0.42	0.00	0.57	0.00	0.00	0.00	1.00	0.00
C_INLET_01	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
CULVERT_01	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.00	0.51
CULVERT_02	1.00	0.00	0.00	0.00	0.56	0.44	0.00	0.00	0.00	0.38
CULVERT_03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
CULVERT_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
OUTLET_01	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STM_01	1.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.37	0.00
STM_02	1.00	0.00	0.36	0.00	0.63	0.01	0.00	0.00	0.98	0.00
STM_03	1.00	0.00	0.00	0.00	0.59	0.00	0.00	0.41	0.09	0.00
STM_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.49	0.00
STM_05	1.00	0.00	0.00	0.00	0.36	0.63	0.00	0.00	0.00	0.00

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Conduit Surcharge Summary
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No conduits were surcharged.

Analysis begun on: Wed Sep 20 15:55:49 2017
Analysis ended on: Wed Sep 20 15:55:55 2017
Total elapsed time: 00:00:06

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)

This model will show the existing and proposed scenario(s) for the Campbell River Landfill project.

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 20
Number of nodes 27
Number of links 26
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_24h_Type_IA_118.2mm	100yr_SCS_24h_Type_IA_118.2mm	VOLUME	15 min.
10yr_SCS_24h_Type_IA_90.1mm	10yr_SCS_24h_Type_IA_90.1mm	VOLUME	15 min.
25yr_SCS_24h_Type_IA_101.5mm	25yr_SCS_24h_Type_IA_101.5mm	VOLUME	15 min.
5yr_SCS_24h_Type_IA_81.2mm	5yr_SCS_24h_Type_IA_81.2mm	VOLUME	15 min.

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Subcatchment Summary
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Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
Block_K	2.37	153.95	25.00	15.0000	10yr_SCS_24h_Type_IA_90.1mm	S_014
External_01	0.22	9.74	25.00	15.0000	10yr_SCS_24h_Type_IA_90.1mm	D_001
External_02	0.11	5.19	25.00	15.0000	10yr_SCS_24h_Type_IA_90.1mm	D_002
External_03	4.56	206.11	25.00	15.0000	10yr_SCS_24h_Type_IA_90.1mm	SW_Pond
External_04	1.03	101.66	25.00	15.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C006
S_001	0.30	54.46	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C011
S_002	0.98	98.93	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C010
S_003	0.72	85.11	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C008
S_004	1.15	107.14	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C009
S_005	1.35	116.27	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C012
S_006	0.70	83.93	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C006
S_007	1.38	117.36	85.00	5.0000	10yr_SCS_24h_Type_IA_90.1mm	D_B004
S_008	1.64	128.15	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_B004
S_009	0.50	70.42	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_B005
S_010	0.46	67.93	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_A004
S_011	0.40	63.45	25.00	15.0000	10yr_SCS_24h_Type_IA_90.1mm	D_B003
S_013	0.37	60.80	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C003
S_014	0.24	49.19	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C003
S_14	0.37	33.58	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_C002
S_2	0.85	77.08	85.00	30.0000	10yr_SCS_24h_Type_IA_90.1mm	D_001

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Node Summary
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Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow

Control_MH	JUNCTION	134.25	2.00	0.0
D_001	JUNCTION	138.00	0.50	0.0
D_002	JUNCTION	139.00	0.50	0.0
D_A001	JUNCTION	136.77	1.00	0.0
D_A003	JUNCTION	142.34	1.00	0.0
D_A004	JUNCTION	152.22	0.50	0.0
D_B001	JUNCTION	136.77	1.00	0.0
D_B003	JUNCTION	139.89	0.53	0.0
D_B004	JUNCTION	159.26	0.50	0.0
D_B005	JUNCTION	152.22	0.50	0.0
D_C001	JUNCTION	136.50	1.00	0.0
D_C002	JUNCTION	158.72	0.50	0.0
D_C003	JUNCTION	160.20	1.00	0.0
D_C004	JUNCTION	160.37	1.00	0.0
D_C005	JUNCTION	160.40	0.60	0.0
D_C006	JUNCTION	162.48	1.00	0.0
D_C007	JUNCTION	162.78	1.00	0.0
D_C008	JUNCTION	165.53	0.50	0.0
D_C009	JUNCTION	172.12	0.50	0.0
D_C010	JUNCTION	176.75	0.50	0.0
D_C011	JUNCTION	190.50	0.50	0.0
D_C012	JUNCTION	172.12	0.50	0.0
DO_001	JUNCTION	136.20	1.00	0.0
DO_002	JUNCTION	136.73	1.00	0.0
J1	JUNCTION	137.01	1.61	0.0
OF1	OUTFALL	132.25	0.45	0.0
SW_Pond	STORAGE	134.50	1.75	0.0

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
C_01	D_C011	D_C010	CONDUIT	141.4	9.7712	0.0350
C_02	D_C010	D_C007	CONDUIT	138.1	10.1710	0.0350
C_03	D_C008	D_C007	CONDUIT	139.9	1.9664	0.0350
C_04	D_C009	D_C008	CONDUIT	256.6	2.5686	0.0350
C_05	D_C012	D_C005	CONDUIT	283.7	4.1351	0.0350
C_06	D_C006	D_C005	CONDUIT	208.5	0.9975	0.0350
C_07	D_B004	D_B003	CONDUIT	257.5	7.5440	0.0350
C_09	D_B005	D_B003	CONDUIT	67.7	18.5197	0.0350
C_10	D_A004	D_A003	CONDUIT	111.7	8.8767	0.0350
C_12	D_C002	D_C001	CONDUIT	148.6	15.1229	0.0350
C_13	D_C003	D_C002	CONDUIT	148.1	0.9995	0.0350
C_14	D_C005	D_C004	CONDUIT	3.2	0.9288	0.0350
C_15	D_001	D_C001	CONDUIT	65.7	2.2827	0.0350
C_16	D_002	D_C001	CONDUIT	12.1	21.0260	0.0350
C_INLET_01	DO_001	SW_Pond	CONDUIT	14.8	4.7511	0.0350
CULVERT_01	D_B003	D_B001	CONDUIT	214.7	1.4531	0.0220
CULVERT_02	D_C007	D_C006	CONDUIT	23.2	1.2915	0.0220
CULVERT_03	D_C004	D_C003	CONDUIT	16.8	1.0102	0.0130
CULVERT_04	D_C001	DO_001	CONDUIT	34.0	0.8824	0.0130
OUTLET_01	Control_MH	OF1	CONDUIT	200.0	1.0001	0.0130
STM_01	D_A003	J1	CONDUIT	19.1	29.0176	0.0130
STM_02	J1	D_A001	CONDUIT	18.8	1.2767	0.0130
STM_03	D_A001	DO_002	CONDUIT	5.8	0.5190	0.0100
STM_04	D_B001	DO_002	CONDUIT	6.0	0.6645	0.0100
STM_05	DO_002	DO_001	CONDUIT	108.8	0.4873	0.0130
W1	SW_Pond	Control_MH	WEIR			

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C_01	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.11
C_02	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.15
C_03	TRAPEZOIDAL	0.50	1.12	0.30	3.50	1	2.04
C_04	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.08
C_05	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.37
C_06	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.30
C_07	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	3.59
C_09	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.90
C_10	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.01
C_12	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.08
C_13	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.31
C_14	TRAPEZOIDAL	0.60	1.80	0.40	4.20	1	2.70
C_15	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.97
C_16	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.99
C_INLET_01	TRAPEZOIDAL	0.50	1.50	0.35	4.00	1	4.68
CULVERT_01	CIRCULAR	0.53	0.22	0.13	0.53	1	0.31
CULVERT_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.29
CULVERT_03	RECT_CLOSED	0.90	1.62	0.30	1.80	1	5.61
CULVERT_04	RECT_CLOSED	0.90	1.62	0.30	1.80	2	5.25
OUTLET_01	CIRCULAR	0.45	0.16	0.11	0.45	1	0.29
STM_01	CIRCULAR	0.25	0.05	0.06	0.25	1	0.32
STM_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.49
STM_03	CIRCULAR	0.53	0.22	0.13	0.53	1	0.40
STM_04	CIRCULAR	0.53	0.22	0.13	0.53	1	0.46
STM_05	CIRCULAR	0.53	0.22	0.13	0.53	1	0.30

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Transect Summary
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Transect v-ditch_01
Area:

0.0004	0.0016	0.0036	0.0064	0.0100
0.0144	0.0196	0.0256	0.0324	0.0400
0.0484	0.0576	0.0676	0.0784	0.0900
0.1024	0.1156	0.1296	0.1444	0.1600
0.1764	0.1936	0.2116	0.2304	0.2500
0.2704	0.2916	0.3136	0.3364	0.3600
0.3844	0.4096	0.4356	0.4624	0.4900
0.5184	0.5476	0.5776	0.6084	0.6400
0.6724	0.7056	0.7396	0.7744	0.8100
0.8464	0.8836	0.9216	0.9604	1.0000

Hrad:

0.0200	0.0400	0.0600	0.0800	0.1000
0.1200	0.1400	0.1600	0.1800	0.2000
0.2200	0.2400	0.2600	0.2800	0.3000
0.3200	0.3400	0.3600	0.3800	0.4000
0.4200	0.4400	0.4600	0.4800	0.5000
0.5200	0.5400	0.5600	0.5800	0.6000
0.6200	0.6400	0.6600	0.6800	0.7000
0.7200	0.7400	0.7600	0.7800	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

Width:

0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_01(orig)
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_02
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000

0.3200	0.3400	0.3600	0.3800	0.4000
0.4200	0.4400	0.4600	0.4800	0.5000
0.5200	0.5400	0.5600	0.5800	0.6000
0.6200	0.6400	0.6600	0.6800	0.7000
0.7200	0.7400	0.7600	0.7800	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

Width:

0.0200	0.0400	0.0600	0.0800	0.1000
0.1200	0.1400	0.1600	0.1800	0.2000
0.2200	0.2400	0.2600	0.2800	0.3000
0.3200	0.3400	0.3600	0.3800	0.4000
0.4200	0.4400	0.4600	0.4800	0.5000
0.5200	0.5400	0.5600	0.5800	0.6000
0.6200	0.6400	0.6600	0.6800	0.7000
0.7200	0.7400	0.7600	0.7800	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

****
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 02/14/2017 00:00:00
Ending Date 02/16/2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:15
Wet Time Step 00:00:05
Dry Time Step 00:00:15
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 4
Head Tolerance ..... 0.001500 m

********** Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	1.776	90.098
Evaporation Loss	0.000	0.000
Infiltration Loss	0.477	24.226
Surface Runoff	1.291	65.492
Final Storage	0.007	0.380
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.291	12.908
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	1.291	12.908
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.000	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link CULVERT_02 (6)

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
Block_K	90.10	0.00	0.00	56.41	33.50	0.79	0.07	0.372
External_01	90.10	0.00	0.00	56.64	33.27	0.07	0.01	0.369
External_02	90.10	0.00	0.00	56.64	33.27	0.04	0.00	0.369
External_03	90.10	0.00	0.00	56.64	33.27	1.52	0.12	0.369
External_04	90.10	0.00	0.00	56.23	33.68	0.35	0.03	0.374
S_001	90.10	0.00	0.00	0.11	89.38	0.27	0.01	0.992
S_002	90.10	0.00	0.00	0.11	89.38	0.87	0.04	0.992
S_003	90.10	0.00	0.00	0.11	89.38	0.65	0.03	0.992
S_004	90.10	0.00	0.00	0.11	89.38	1.03	0.05	0.992
S_005	90.10	0.00	0.00	0.11	89.38	1.21	0.05	0.992
S_006	90.10	0.00	0.00	0.11	89.38	0.63	0.03	0.992

S_007	90.10	0.00	0.00	1.94	88.12	1.21	0.05	0.978
S_008	90.10	0.00	0.00	0.11	89.38	1.47	0.06	0.992
S_009	90.10	0.00	0.00	0.11	89.38	0.44	0.02	0.992
S_010	90.10	0.00	0.00	0.11	89.38	0.41	0.02	0.992
S_011	90.10	0.00	0.00	12.83	77.26	0.31	0.02	0.857
S_013	90.10	0.00	0.00	0.11	89.38	0.33	0.01	0.992
S_014	90.10	328.05	0.00	0.11	417.43	1.01	0.07	0.998
S_14	90.10	0.00	0.00	0.11	89.38	0.33	0.01	0.992
S_2	90.10	0.00	0.00	0.11	89.38	0.76	0.03	0.992

****
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
Control_MH	JUNCTION	0.00	0.00	134.25	0 00:00	0.00
D_001	JUNCTION	0.01	0.06	138.06	0 08:00	0.06
D_002	JUNCTION	0.00	0.01	139.01	0 08:00	0.01
D_A001	JUNCTION	0.06	0.29	137.06	0 08:00	0.29
D_A003	JUNCTION	0.01	0.04	142.38	0 08:00	0.04
D_A004	JUNCTION	0.03	0.10	152.32	0 08:00	0.10
D_B001	JUNCTION	0.06	0.29	137.06	0 08:00	0.29
D_B003	JUNCTION	0.08	0.40	140.29	0 08:00	0.40
D_B004	JUNCTION	0.02	0.08	159.34	0 08:00	0.08
D_B005	JUNCTION	0.02	0.08	152.30	0 08:00	0.08
D_C001	JUNCTION	0.03	0.18	136.68	0 08:00	0.18
D_C002	JUNCTION	0.02	0.12	158.84	0 08:00	0.12
D_C003	JUNCTION	0.06	0.27	160.47	0 08:00	0.27
D_C004	JUNCTION	0.04	0.21	160.58	0 08:00	0.21
D_C005	JUNCTION	0.03	0.19	160.59	0 08:00	0.19
D_C006	JUNCTION	0.04	0.18	162.66	0 07:59	0.18
D_C007	JUNCTION	0.07	0.34	163.12	0 07:42	0.34
D_C008	JUNCTION	0.02	0.09	165.62	0 08:00	0.09
D_C009	JUNCTION	0.05	0.17	172.29	0 08:00	0.17
D_C010	JUNCTION	0.04	0.12	176.87	0 08:00	0.12
D_C011	JUNCTION	0.02	0.07	190.57	0 08:00	0.07
D_C012	JUNCTION	0.05	0.15	172.27	0 07:10	0.15
DO_001	JUNCTION	0.03	0.15	136.35	0 08:00	0.15
DO_002	JUNCTION	0.08	0.33	137.06	0 08:00	0.33
J1	JUNCTION	0.02	0.07	137.08	0 08:00	0.07
OF1	OUTFALL	0.00	0.00	132.25	0 00:00	0.00
SW_Pond	STORAGE	0.23	0.65	135.15	0 11:46	0.65

****
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
Control_MH	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
D_001	JUNCTION	0.039	0.039	0 08:00	0.834	0.834	-0.007
D_002	JUNCTION	0.003	0.003	0 08:00	0.0382	0.0382	-0.000

D_A001	JUNCTION	0.000	0.018	0	08:00	0	0.458	0.068
D_A003	JUNCTION	0.000	0.018	0	08:00	0	0.412	0.003
D_A004	JUNCTION	0.018	0.018	0	08:00	0.412	0.412	-0.001
D_B001	JUNCTION	0.000	0.152	0	08:00	0	3.43	-0.023
D_B003	JUNCTION	0.015	0.153	0	08:00	0.311	3.44	0.056
D_B004	JUNCTION	0.118	0.118	0	08:00	2.68	2.68	-0.028
D_B005	JUNCTION	0.019	0.019	0	08:00	0.443	0.443	-0.063
D_C001	JUNCTION	0.000	0.378	0	08:00	0	7.54	0.001
D_C002	JUNCTION	0.015	0.337	0	08:00	0.332	6.67	0.000
D_C003	JUNCTION	0.089	0.323	0	08:00	1.34	6.34	0.000
D_C004	JUNCTION	0.000	0.234	0	08:00	0	5	0.000
D_C005	JUNCTION	0.000	0.235	0	07:59	0	5	0.018
D_C006	JUNCTION	0.058	0.184	0	07:59	0.978	3.79	-0.080
D_C007	JUNCTION	0.000	0.124	0	08:00	0	2.81	0.150
D_C008	JUNCTION	0.028	0.074	0	08:00	0.647	1.67	-0.021
D_C009	JUNCTION	0.045	0.045	0	08:00	1.03	1.03	-0.008
D_C010	JUNCTION	0.038	0.050	0	08:00	0.875	1.14	-0.062
D_C011	JUNCTION	0.012	0.012	0	08:00	0.265	0.265	-0.013
D_C012	JUNCTION	0.053	0.053	0	08:00	1.21	1.21	-0.068
DO_001	JUNCTION	0.000	0.548	0	08:00	0	11.4	0.001
DO_002	JUNCTION	0.000	0.170	0	08:00	0	3.89	-0.009
J1	JUNCTION	0.000	0.018	0	08:00	0	0.412	-0.004
OF1	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
SW_Pond	STORAGE	0.115	0.662	0	08:00	1.52	12.9	-0.000

****
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
SW_Pond	1.361	11	0	100	3.905	33	0 11:46	0.148

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	0.00	0.000	0.000	0.000

System 0.00 0.000 0.000 0.000

****
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
C_01	CONDUIT	0.012	0	07:59	0.51	0.01	0.19
C_02	CONDUIT	0.050	0	08:00	1.32	0.02	0.47
C_03	CONDUIT	0.074	0	08:00	0.29	0.04	0.43
C_04	CONDUIT	0.045	0	08:00	1.12	0.04	0.26
C_05	CONDUIT	0.054	0	07:15	1.10	0.04	0.33
C_06	CONDUIT	0.181	0	07:59	0.73	0.14	0.36
C_07	CONDUIT	0.118	0	08:00	0.48	0.03	0.48
C_09	CONDUIT	0.019	0	08:00	1.49	0.01	0.48
C_10	CONDUIT	0.018	0	08:00	1.53	0.01	0.14
C_12	CONDUIT	0.337	0	08:00	1.75	0.07	0.30
C_13	CONDUIT	0.322	0	08:00	1.21	0.25	0.38
C_14	CONDUIT	0.234	0	08:00	0.54	0.09	0.33
C_15	CONDUIT	0.039	0	08:00	0.37	0.02	0.24
C_16	CONDUIT	0.003	0	08:00	0.03	0.00	0.18
C_INLET_01	CONDUIT	0.548	0	08:00	1.59	0.12	0.30
CULVERT_01	CONDUIT	0.152	0	08:00	1.21	0.50	0.66
CULVERT_02	CONDUIT	0.127	0	07:33	1.31	0.44	0.50
CULVERT_03	CONDUIT	0.234	0	08:00	0.55	0.04	0.26
CULVERT_04	CONDUIT	0.378	0	08:00	0.64	0.04	0.18
OUTLET_01	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
STM_01	CONDUIT	0.018	0	08:00	2.61	0.06	0.20
STM_02	CONDUIT	0.018	0	08:00	0.55	0.04	0.34
STM_03	CONDUIT	0.021	0	07:20	0.50	0.05	0.57
STM_04	CONDUIT	0.152	0	08:01	1.19	0.33	0.58
STM_05	CONDUIT	0.170	0	08:00	1.78	0.57	0.45
W1	WEIR	0.000	0	00:00		0.00	

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Up Dry	Down Dry	Sub Dry	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C_01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_02	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_03	1.00	0.00	0.05	0.00	0.95	0.00	0.00	1.00	0.00
C_04	1.00	0.00	0.00	0.00	0.37	0.63	0.00	0.00	0.00
C_05	1.00	0.00	0.00	0.00	0.44	0.55	0.00	0.18	0.00
C_06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.50	0.00
C_07	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_09	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_10	1.00	0.00	0.00	0.00	0.42	0.58	0.00	0.00	0.00
C_12	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.50	0.00
C_13	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
C_14	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.25	0.00

C_15	1.00	0.00	0.11	0.00	0.88	0.00	0.00	0.00	0.99	0.00
C_16	1.00	0.00	0.42	0.00	0.58	0.00	0.00	0.00	1.00	0.00
C_INLET_01	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
CULVERT_01	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.00	0.55
CULVERT_02	1.00	0.00	0.00	0.00	0.54	0.45	0.00	0.00	0.00	0.43
CULVERT_03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
CULVERT_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
OUTLET_01	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STM_01	1.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.46	0.00
STM_02	1.00	0.00	0.22	0.00	0.77	0.01	0.00	0.00	0.98	0.00
STM_03	1.00	0.00	0.00	0.00	0.59	0.00	0.00	0.41	0.09	0.00
STM_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.49	0.00
STM_05	1.00	0.00	0.00	0.00	0.36	0.63	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Sep 20 15:56:41 2017
Analysis ended on: Wed Sep 20 15:56:47 2017
Total elapsed time: 00:00:06

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)

This model will show the existing and proposed scenario(s) for the Campbell River Landfill project.

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 20
Number of nodes 27
Number of links 26
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_24h_Type_IA_118.2mm	100yr_SCS_24h_Type_IA_118.2mm	VOLUME	15 min.
10yr_SCS_24h_Type_IA_90.1mm	10yr_SCS_24h_Type_IA_90.1mm	VOLUME	15 min.
25yr_SCS_24h_Type_IA_101.5mm	25yr_SCS_24h_Type_IA_101.5mm	VOLUME	15 min.
5yr_SCS_24h_Type_IA_81.2mm	5yr_SCS_24h_Type_IA_81.2mm	VOLUME	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
Block_K	2.37	153.95	25.00	15.0000	25yr_SCS_24h_Type_IA_101.5mm	S_014
External_01	0.22	9.74	25.00	15.0000	25yr_SCS_24h_Type_IA_101.5mm	D_001
External_02	0.11	5.19	25.00	15.0000	25yr_SCS_24h_Type_IA_101.5mm	D_002
External_03	4.56	206.11	25.00	15.0000	25yr_SCS_24h_Type_IA_101.5mm	SW_Pond
External_04	1.03	101.66	25.00	15.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C006
S_001	0.30	54.46	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C011
S_002	0.98	98.93	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C010
S_003	0.72	85.11	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C008
S_004	1.15	107.14	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C009
S_005	1.35	116.27	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C012
S_006	0.70	83.93	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C006
S_007	1.38	117.36	85.00	5.0000	25yr_SCS_24h_Type_IA_101.5mm	D_B004
S_008	1.64	128.15	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_B004
S_009	0.50	70.42	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_B005
S_010	0.46	67.93	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_A004
S_011	0.40	63.45	25.00	15.0000	25yr_SCS_24h_Type_IA_101.5mm	D_B003
S_013	0.37	60.80	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C003
S_014	0.24	49.19	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C003
S_14	0.37	33.58	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_C002
S_2	0.85	77.08	85.00	30.0000	25yr_SCS_24h_Type_IA_101.5mm	D_001

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Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow

Control_MH	JUNCTION	134.25	2.00	0.0
D_001	JUNCTION	138.00	0.50	0.0
D_002	JUNCTION	139.00	0.50	0.0
D_A001	JUNCTION	136.77	1.00	0.0
D_A003	JUNCTION	142.34	1.00	0.0
D_A004	JUNCTION	152.22	0.50	0.0
D_B001	JUNCTION	136.77	1.00	0.0
D_B003	JUNCTION	139.89	0.53	0.0
D_B004	JUNCTION	159.26	0.50	0.0
D_B005	JUNCTION	152.22	0.50	0.0
D_C001	JUNCTION	136.50	1.00	0.0
D_C002	JUNCTION	158.72	0.50	0.0
D_C003	JUNCTION	160.20	1.00	0.0
D_C004	JUNCTION	160.37	1.00	0.0
D_C005	JUNCTION	160.40	0.60	0.0
D_C006	JUNCTION	162.48	1.00	0.0
D_C007	JUNCTION	162.78	1.00	0.0
D_C008	JUNCTION	165.53	0.50	0.0
D_C009	JUNCTION	172.12	0.50	0.0
D_C010	JUNCTION	176.75	0.50	0.0
D_C011	JUNCTION	190.50	0.50	0.0
D_C012	JUNCTION	172.12	0.50	0.0
DO_001	JUNCTION	136.20	1.00	0.0
DO_002	JUNCTION	136.73	1.00	0.0
J1	JUNCTION	137.01	1.61	0.0
OF1	OUTFALL	132.25	0.45	0.0
SW_Pond	STORAGE	134.50	1.75	0.0

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
C_01	D_C011	D_C010	CONDUIT	141.4	9.7712	0.0350
C_02	D_C010	D_C007	CONDUIT	138.1	10.1710	0.0350
C_03	D_C008	D_C007	CONDUIT	139.9	1.9664	0.0350
C_04	D_C009	D_C008	CONDUIT	256.6	2.5686	0.0350
C_05	D_C012	D_C005	CONDUIT	283.7	4.1351	0.0350
C_06	D_C006	D_C005	CONDUIT	208.5	0.9975	0.0350
C_07	D_B004	D_B003	CONDUIT	257.5	7.5440	0.0350
C_09	D_B005	D_B003	CONDUIT	67.7	18.5197	0.0350
C_10	D_A004	D_A003	CONDUIT	111.7	8.8767	0.0350
C_12	D_C002	D_C001	CONDUIT	148.6	15.1229	0.0350
C_13	D_C003	D_C002	CONDUIT	148.1	0.9995	0.0350
C_14	D_C005	D_C004	CONDUIT	3.2	0.9288	0.0350
C_15	D_001	D_C001	CONDUIT	65.7	2.2827	0.0350
C_16	D_002	D_C001	CONDUIT	12.1	21.0260	0.0350
C_INLET_01	DO_001	SW_Pond	CONDUIT	14.8	4.7511	0.0350
CULVERT_01	D_B003	D_B001	CONDUIT	214.7	1.4531	0.0220
CULVERT_02	D_C007	D_C006	CONDUIT	23.2	1.2915	0.0220
CULVERT_03	D_C004	D_C003	CONDUIT	16.8	1.0102	0.0130
CULVERT_04	D_C001	DO_001	CONDUIT	34.0	0.8824	0.0130
OUTLET_01	Control_MH	OF1	CONDUIT	200.0	1.0001	0.0130
STM_01	D_A003	J1	CONDUIT	19.1	29.0176	0.0130
STM_02	J1	D_A001	CONDUIT	18.8	1.2767	0.0130
STM_03	D_A001	DO_002	CONDUIT	5.8	0.5190	0.0100
STM_04	D_B001	DO_002	CONDUIT	6.0	0.6645	0.0100
STM_05	DO_002	DO_001	CONDUIT	108.8	0.4873	0.0130
W1	SW_Pond	Control_MH	WEIR			

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C_01	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.11
C_02	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.15
C_03	TRAPEZOIDAL	0.50	1.12	0.30	3.50	1	2.04
C_04	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.08
C_05	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.37
C_06	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.30
C_07	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	3.59
C_09	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.90
C_10	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.01
C_12	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.08
C_13	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.31
C_14	TRAPEZOIDAL	0.60	1.80	0.40	4.20	1	2.70
C_15	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.97
C_16	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.99
C_INLET_01	TRAPEZOIDAL	0.50	1.50	0.35	4.00	1	4.68
CULVERT_01	CIRCULAR	0.53	0.22	0.13	0.53	1	0.31
CULVERT_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.29
CULVERT_03	RECT_CLOSED	0.90	1.62	0.30	1.80	1	5.61
CULVERT_04	RECT_CLOSED	0.90	1.62	0.30	1.80	2	5.25
OUTLET_01	CIRCULAR	0.45	0.16	0.11	0.45	1	0.29
STM_01	CIRCULAR	0.25	0.05	0.06	0.25	1	0.32
STM_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.49
STM_03	CIRCULAR	0.53	0.22	0.13	0.53	1	0.40
STM_04	CIRCULAR	0.53	0.22	0.13	0.53	1	0.46
STM_05	CIRCULAR	0.53	0.22	0.13	0.53	1	0.30

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Transect Summary
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Transect v-ditch_01
Area:

0.0004	0.0016	0.0036	0.0064	0.0100
0.0144	0.0196	0.0256	0.0324	0.0400
0.0484	0.0576	0.0676	0.0784	0.0900
0.1024	0.1156	0.1296	0.1444	0.1600
0.1764	0.1936	0.2116	0.2304	0.2500
0.2704	0.2916	0.3136	0.3364	0.3600
0.3844	0.4096	0.4356	0.4624	0.4900
0.5184	0.5476	0.5776	0.6084	0.6400
0.6724	0.7056	0.7396	0.7744	0.8100
0.8464	0.8836	0.9216	0.9604	1.0000

Hrad:

0.0200	0.0400	0.0600	0.0800	0.1000
0.1200	0.1400	0.1600	0.1800	0.2000
0.2200	0.2400	0.2600	0.2800	0.3000
0.3200	0.3400	0.3600	0.3800	0.4000
0.4200	0.4400	0.4600	0.4800	0.5000
0.5200	0.5400	0.5600	0.5800	0.6000
0.6200	0.6400	0.6600	0.6800	0.7000
0.7200	0.7400	0.7600	0.7800	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

Width:

0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_01(orig)
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_02
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000

0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

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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.
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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 02/14/2017 00:00:00
Ending Date 02/16/2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:15
Wet Time Step 00:00:05
Dry Time Step 00:00:15
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 4
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	2.000	101.484
Evaporation Loss	0.000	0.000
Infiltration Loss	0.513	26.026
Surface Runoff	1.480	75.078
Final Storage	0.007	0.380
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.480	14.797
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	1.480	14.797
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.000	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link CULVERT_02 (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
Block_K	101.48	0.00	0.00	60.71	40.59	0.96	0.08	0.400
External_01	101.48	0.00	0.00	60.90	40.40	0.09	0.01	0.398
External_02	101.48	0.00	0.00	60.90	40.40	0.05	0.00	0.398
External_03	101.48	0.00	0.00	60.90	40.40	1.84	0.14	0.398
External_04	101.48	0.00	0.00	60.56	40.74	0.42	0.04	0.401
S_001	101.48	0.00	0.00	0.11	100.77	0.30	0.01	0.993
S_002	101.48	0.00	0.00	0.11	100.76	0.99	0.04	0.993
S_003	101.48	0.00	0.00	0.11	100.76	0.73	0.03	0.993
S_004	101.48	0.00	0.00	0.11	100.76	1.16	0.05	0.993
S_005	101.48	0.00	0.00	0.11	100.76	1.36	0.06	0.993
S_006	101.48	0.00	0.00	0.11	100.76	0.71	0.03	0.993

S_007	101.48	0.00	0.00	1.95	99.50	1.37	0.06	0.980
S_008	101.48	0.00	0.00	0.11	100.76	1.65	0.07	0.993
S_009	101.48	0.00	0.00	0.11	100.76	0.50	0.02	0.993
S_010	101.48	0.00	0.00	0.11	100.76	0.46	0.02	0.993
S_011	101.48	0.00	0.00	12.85	88.62	0.36	0.02	0.873
S_013	101.48	0.00	0.00	0.11	100.76	0.37	0.02	0.993
S_014	101.48	397.49	0.00	0.11	498.26	1.21	0.09	0.999
S_14	101.48	0.00	0.00	0.11	100.76	0.37	0.02	0.993
S_2	101.48	0.00	0.00	0.11	100.76	0.86	0.04	0.993

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Node Depth Summary
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Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
Control_MH	JUNCTION	0.00	0.00	134.25	0 00:00	0.00
D_001	JUNCTION	0.01	0.06	138.06	0 08:00	0.06
D_002	JUNCTION	0.00	0.01	139.01	0 08:00	0.01
D_A001	JUNCTION	0.06	0.31	137.08	0 08:00	0.31
D_A003	JUNCTION	0.01	0.04	142.38	0 08:00	0.04
D_A004	JUNCTION	0.03	0.10	152.32	0 08:00	0.10
D_B001	JUNCTION	0.07	0.31	137.08	0 08:00	0.31
D_B003	JUNCTION	0.09	0.44	140.33	0 07:59	0.44
D_B004	JUNCTION	0.02	0.08	159.34	0 08:00	0.08
D_B005	JUNCTION	0.02	0.08	152.30	0 08:00	0.08
D_C001	JUNCTION	0.03	0.20	136.70	0 08:00	0.20
D_C002	JUNCTION	0.03	0.13	158.85	0 08:00	0.13
D_C003	JUNCTION	0.07	0.29	160.49	0 08:00	0.29
D_C004	JUNCTION	0.04	0.23	160.60	0 08:00	0.23
D_C005	JUNCTION	0.04	0.20	160.60	0 08:00	0.20
D_C006	JUNCTION	0.04	0.19	162.67	0 07:59	0.19
D_C007	JUNCTION	0.08	0.34	163.12	0 07:19	0.34
D_C008	JUNCTION	0.02	0.09	165.62	0 08:00	0.09
D_C009	JUNCTION	0.06	0.18	172.30	0 08:00	0.18
D_C010	JUNCTION	0.04	0.13	176.88	0 08:00	0.13
D_C011	JUNCTION	0.02	0.07	190.57	0 08:00	0.07
D_C012	JUNCTION	0.05	0.16	172.28	0 07:09	0.16
DO_001	JUNCTION	0.03	0.16	136.36	0 08:00	0.16
DO_002	JUNCTION	0.08	0.35	137.08	0 08:00	0.35
J1	JUNCTION	0.02	0.07	137.08	0 08:00	0.07
OF1	OUTFALL	0.00	0.00	132.25	0 00:00	0.00
SW_Pond	STORAGE	0.32	0.81	135.31	0 12:12	0.81

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Node Inflow Summary
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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
Control_MH	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
D_001	JUNCTION	0.045	0.045	0 08:00	0.946	0.946	-0.007
D_002	JUNCTION	0.004	0.004	0 08:00	0.0463	0.0463	-0.000

D_A001	JUNCTION	0.000	0.020	0	07:59	0	0.504	0.055
D_A003	JUNCTION	0.000	0.020	0	08:00	0	0.465	0.003
D_A004	JUNCTION	0.020	0.020	0	08:00	0.465	0.465	-0.001
D_B001	JUNCTION	0.000	0.173	0	07:59	0	3.88	0.001
D_B003	JUNCTION	0.017	0.173	0	08:00	0.357	3.88	0.033
D_B004	JUNCTION	0.133	0.133	0	08:00	3.03	3.03	-0.029
D_B005	JUNCTION	0.022	0.022	0	08:00	0.5	0.5	-0.064
D_C001	JUNCTION	0.000	0.436	0	08:00	0	8.61	0.001
D_C002	JUNCTION	0.016	0.388	0	08:00	0.374	7.62	0.000
D_C003	JUNCTION	0.106	0.372	0	08:00	1.58	7.24	0.000
D_C004	JUNCTION	0.000	0.266	0	08:00	0	5.66	0.000
D_C005	JUNCTION	0.000	0.266	0	07:59	0	5.67	0.018
D_C006	JUNCTION	0.067	0.215	0	08:00	1.13	4.3	-0.081
D_C007	JUNCTION	0.000	0.139	0	08:00	0	3.17	0.148
D_C008	JUNCTION	0.032	0.083	0	08:00	0.73	1.89	-0.019
D_C009	JUNCTION	0.051	0.051	0	08:00	1.16	1.16	-0.008
D_C010	JUNCTION	0.043	0.056	0	08:00	0.986	1.29	-0.058
D_C011	JUNCTION	0.013	0.013	0	08:00	0.299	0.299	-0.012
D_C012	JUNCTION	0.060	0.060	0	08:00	1.36	1.36	-0.067
DO_001	JUNCTION	0.000	0.628	0	08:00	0	13	0.000
DO_002	JUNCTION	0.000	0.193	0	07:59	0	4.39	-0.007
J1	JUNCTION	0.000	0.020	0	07:59	0	0.465	-0.004
OF1	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
SW_Pond	STORAGE	0.143	0.771	0	08:00	1.84	14.8	-0.000

****
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
SW_Pond	1.931	16	0	100	4.940	42	0 12:12	0.159

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	0.00	0.000	0.000	0.000

System 0.00 0.000 0.000 0.000

****
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
C_01	CONDUIT	0.013	0	07:57	0.53	0.01	0.20
C_02	CONDUIT	0.056	0	08:00	1.36	0.03	0.47
C_03	CONDUIT	0.083	0	08:00	0.30	0.04	0.44
C_04	CONDUIT	0.051	0	08:00	1.14	0.05	0.27
C_05	CONDUIT	0.061	0	07:12	1.11	0.04	0.36
C_06	CONDUIT	0.207	0	07:59	0.76	0.16	0.40
C_07	CONDUIT	0.133	0	08:00	0.49	0.04	0.52
C_09	CONDUIT	0.022	0	08:00	1.53	0.01	0.52
C_10	CONDUIT	0.020	0	08:00	1.57	0.01	0.14
C_12	CONDUIT	0.388	0	08:00	1.81	0.08	0.32
C_13	CONDUIT	0.372	0	08:00	1.27	0.28	0.41
C_14	CONDUIT	0.266	0	08:00	0.56	0.10	0.36
C_15	CONDUIT	0.044	0	08:00	0.38	0.02	0.26
C_16	CONDUIT	0.004	0	08:00	0.03	0.00	0.20
C_INLET_01	CONDUIT	0.628	0	08:00	1.67	0.13	0.32
CULVERT_01	CONDUIT	0.173	0	07:59	1.16	0.56	0.71
CULVERT_02	CONDUIT	0.150	0	07:19	1.41	0.52	0.51
CULVERT_03	CONDUIT	0.266	0	08:00	0.58	0.05	0.28
CULVERT_04	CONDUIT	0.435	0	08:00	0.67	0.04	0.20
OUTLET_01	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
STM_01	CONDUIT	0.020	0	07:59	2.68	0.06	0.21
STM_02	CONDUIT	0.020	0	07:59	0.57	0.04	0.37
STM_03	CONDUIT	0.020	0	08:00	0.52	0.05	0.63
STM_04	CONDUIT	0.173	0	07:59	1.20	0.38	0.63
STM_05	CONDUIT	0.193	0	08:00	1.82	0.64	0.49
W1	WEIR	0.000	0	00:00		0.00	

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Up Dry	Down Dry	Sub Dry	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C_01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_02	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_03	1.00	0.00	0.05	0.00	0.95	0.00	0.00	1.00	0.00
C_04	1.00	0.00	0.00	0.00	0.37	0.63	0.00	0.00	0.00
C_05	1.00	0.00	0.00	0.00	0.45	0.55	0.00	0.18	0.00
C_06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.51	0.00
C_07	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_09	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_10	1.00	0.00	0.00	0.00	0.42	0.58	0.00	0.00	0.00
C_12	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.50	0.00
C_13	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.00
C_14	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.20	0.00

C_15	1.00	0.00	0.11	0.00	0.88	0.00	0.00	0.00	0.99	0.00
C_16	1.00	0.00	0.42	0.00	0.58	0.00	0.00	0.00	1.00	0.00
C_INLET_01	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
CULVERT_01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.57
CULVERT_02	1.00	0.00	0.00	0.00	0.54	0.46	0.00	0.00	0.00	0.47
CULVERT_03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
CULVERT_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
OUTLET_01	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STM_01	1.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.50	0.00
STM_02	1.00	0.00	0.29	0.00	0.70	0.01	0.00	0.00	0.98	0.00
STM_03	1.00	0.00	0.00	0.00	0.59	0.00	0.00	0.40	0.09	0.00
STM_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.49	0.00
STM_05	1.00	0.00	0.00	0.00	0.36	0.64	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Sep 20 15:37:52 2017
Analysis ended on: Wed Sep 20 15:37:58 2017
Total elapsed time: 00:00:06

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)

This model will show the existing and proposed scenario(s) for the Campbell River Landfill project.

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 20
Number of nodes 27
Number of links 26
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_24h_Type_IA_118.2mm	100yr_SCS_24h_Type_IA_118.2mm	VOLUME	15 min.
10yr_SCS_24h_Type_IA_90.1mm	10yr_SCS_24h_Type_IA_90.1mm	VOLUME	15 min.
25yr_SCS_24h_Type_IA_101.5mm	25yr_SCS_24h_Type_IA_101.5mm	VOLUME	15 min.
5yr_SCS_24h_Type_IA_81.2mm	5yr_SCS_24h_Type_IA_81.2mm	VOLUME	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
Block_K	2.37	153.95	25.00	15.0000	100yr_SCS_24h_Type_IA_118.2mm	S_014
External_01	0.22	9.74	25.00	15.0000	100yr_SCS_24h_Type_IA_118.2mm	D_001
External_02	0.11	5.19	25.00	15.0000	100yr_SCS_24h_Type_IA_118.2mm	D_002
External_03	4.56	206.11	25.00	15.0000	100yr_SCS_24h_Type_IA_118.2mm	SW_Pond
External_04	1.03	101.66	25.00	15.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C006
S_001	0.30	54.46	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C011
S_002	0.98	98.93	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C010
S_003	0.72	85.11	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C008
S_004	1.15	107.14	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C009
S_005	1.35	116.27	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C012
S_006	0.70	83.93	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C006
S_007	1.38	117.36	85.00	5.0000	100yr_SCS_24h_Type_IA_118.2mm	D_B004
S_008	1.64	128.15	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_B004
S_009	0.50	70.42	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_B005
S_010	0.46	67.93	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_A004
S_011	0.40	63.45	25.00	15.0000	100yr_SCS_24h_Type_IA_118.2mm	D_B003
S_013	0.37	60.80	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C003
S_014	0.24	49.19	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C003
S_14	0.37	33.58	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_C002
S_2	0.85	77.08	85.00	30.0000	100yr_SCS_24h_Type_IA_118.2mm	D_001

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Node Summary
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Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow

Control_MH	JUNCTION	134.25	2.00	0.0
D_001	JUNCTION	138.00	0.50	0.0
D_002	JUNCTION	139.00	0.50	0.0
D_A001	JUNCTION	136.77	1.00	0.0
D_A003	JUNCTION	142.34	1.00	0.0
D_A004	JUNCTION	152.22	0.50	0.0
D_B001	JUNCTION	136.77	1.00	0.0
D_B003	JUNCTION	139.89	0.53	0.0
D_B004	JUNCTION	159.26	0.50	0.0
D_B005	JUNCTION	152.22	0.50	0.0
D_C001	JUNCTION	136.50	1.00	0.0
D_C002	JUNCTION	158.72	0.50	0.0
D_C003	JUNCTION	160.20	1.00	0.0
D_C004	JUNCTION	160.37	1.00	0.0
D_C005	JUNCTION	160.40	0.60	0.0
D_C006	JUNCTION	162.48	1.00	0.0
D_C007	JUNCTION	162.78	1.00	0.0
D_C008	JUNCTION	165.53	0.50	0.0
D_C009	JUNCTION	172.12	0.50	0.0
D_C010	JUNCTION	176.75	0.50	0.0
D_C011	JUNCTION	190.50	0.50	0.0
D_C012	JUNCTION	172.12	0.50	0.0
DO_001	JUNCTION	136.20	1.00	0.0
DO_002	JUNCTION	136.73	1.00	0.0
J1	JUNCTION	137.01	1.61	0.0
OF1	OUTFALL	132.25	0.45	0.0
SW_Pond	STORAGE	134.50	1.75	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C_01	D_C011	D_C010	CONDUIT	141.4	9.7712	0.0350
C_02	D_C010	D_C007	CONDUIT	138.1	10.1710	0.0350
C_03	D_C008	D_C007	CONDUIT	139.9	1.9664	0.0350
C_04	D_C009	D_C008	CONDUIT	256.6	2.5686	0.0350
C_05	D_C012	D_C005	CONDUIT	283.7	4.1351	0.0350
C_06	D_C006	D_C005	CONDUIT	208.5	0.9975	0.0350
C_07	D_B004	D_B003	CONDUIT	257.5	7.5440	0.0350
C_09	D_B005	D_B003	CONDUIT	67.7	18.5197	0.0350
C_10	D_A004	D_A003	CONDUIT	111.7	8.8767	0.0350
C_12	D_C002	D_C001	CONDUIT	148.6	15.1229	0.0350
C_13	D_C003	D_C002	CONDUIT	148.1	0.9995	0.0350
C_14	D_C005	D_C004	CONDUIT	3.2	0.9288	0.0350
C_15	D_001	D_C001	CONDUIT	65.7	2.2827	0.0350
C_16	D_002	D_C001	CONDUIT	12.1	21.0260	0.0350
C_INLET_01	DO_001	SW_Pond	CONDUIT	14.8	4.7511	0.0350
CULVERT_01	D_B003	D_B001	CONDUIT	214.7	1.4531	0.0220
CULVERT_02	D_C007	D_C006	CONDUIT	23.2	1.2915	0.0220
CULVERT_03	D_C004	D_C003	CONDUIT	16.8	1.0102	0.0130
CULVERT_04	D_C001	DO_001	CONDUIT	34.0	0.8824	0.0130
OUTLET_01	Control_MH	OF1	CONDUIT	200.0	1.0001	0.0130
STM_01	D_A003	J1	CONDUIT	19.1	29.0176	0.0130
STM_02	J1	D_A001	CONDUIT	18.8	1.2767	0.0130
STM_03	D_A001	DO_002	CONDUIT	5.8	0.5190	0.0100
STM_04	D_B001	DO_002	CONDUIT	6.0	0.6645	0.0100
STM_05	DO_002	DO_001	CONDUIT	108.8	0.4873	0.0130
W1	SW_Pond	Control_MH	WEIR			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C_01	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.11
C_02	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.15
C_03	TRAPEZOIDAL	0.50	1.12	0.30	3.50	1	2.04
C_04	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.08
C_05	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	1.37
C_06	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.30
C_07	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	3.59
C_09	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.90
C_10	TRAPEZOIDAL	0.50	0.62	0.23	2.50	1	2.01
C_12	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.08
C_13	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.31
C_14	TRAPEZOIDAL	0.60	1.80	0.40	4.20	1	2.70
C_15	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	1.97
C_16	TRAPEZOIDAL	0.50	1.00	0.31	3.00	1	5.99
C_INLET_01	TRAPEZOIDAL	0.50	1.50	0.35	4.00	1	4.68
CULVERT_01	CIRCULAR	0.53	0.22	0.13	0.53	1	0.31
CULVERT_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.29
CULVERT_03	RECT_CLOSED	0.90	1.62	0.30	1.80	1	5.61
CULVERT_04	RECT_CLOSED	0.90	1.62	0.30	1.80	2	5.25
OUTLET_01	CIRCULAR	0.45	0.16	0.11	0.45	1	0.29
STM_01	CIRCULAR	0.25	0.05	0.06	0.25	1	0.32
STM_02	CIRCULAR	0.53	0.22	0.13	0.53	1	0.49
STM_03	CIRCULAR	0.53	0.22	0.13	0.53	1	0.40
STM_04	CIRCULAR	0.53	0.22	0.13	0.53	1	0.46
STM_05	CIRCULAR	0.53	0.22	0.13	0.53	1	0.30

****
Transect Summary
****

Transect v-ditch_01
Area:

0.0004	0.0016	0.0036	0.0064	0.0100
0.0144	0.0196	0.0256	0.0324	0.0400
0.0484	0.0576	0.0676	0.0784	0.0900
0.1024	0.1156	0.1296	0.1444	0.1600
0.1764	0.1936	0.2116	0.2304	0.2500
0.2704	0.2916	0.3136	0.3364	0.3600
0.3844	0.4096	0.4356	0.4624	0.4900
0.5184	0.5476	0.5776	0.6084	0.6400
0.6724	0.7056	0.7396	0.7744	0.8100
0.8464	0.8836	0.9216	0.9604	1.0000

Hrad:

0.0200	0.0400	0.0600	0.0800	0.1000
0.1200	0.1400	0.1600	0.1800	0.2000
0.2200	0.2400	0.2600	0.2800	0.3000
0.3200	0.3400	0.3600	0.3800	0.4000
0.4200	0.4400	0.4600	0.4800	0.5000
0.5200	0.5400	0.5600	0.5800	0.6000
0.6200	0.6400	0.6600	0.6800	0.7000
0.7200	0.7400	0.7600	0.7800	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

Width:

0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_01(orig)
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

Transect v-ditch_02
Area:
0.0004 0.0016 0.0036 0.0064 0.0100
0.0144 0.0196 0.0256 0.0324 0.0400
0.0484 0.0576 0.0676 0.0784 0.0900
0.1024 0.1156 0.1296 0.1444 0.1600
0.1764 0.1936 0.2116 0.2304 0.2500
0.2704 0.2916 0.3136 0.3364 0.3600
0.3844 0.4096 0.4356 0.4624 0.4900
0.5184 0.5476 0.5776 0.6084 0.6400
0.6724 0.7056 0.7396 0.7744 0.8100
0.8464 0.8836 0.9216 0.9604 1.0000
Hrad:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000

0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000
Width:
0.0200 0.0400 0.0600 0.0800 0.1000
0.1200 0.1400 0.1600 0.1800 0.2000
0.2200 0.2400 0.2600 0.2800 0.3000
0.3200 0.3400 0.3600 0.3800 0.4000
0.4200 0.4400 0.4600 0.4800 0.5000
0.5200 0.5400 0.5600 0.5800 0.6000
0.6200 0.6400 0.6600 0.6800 0.7000
0.7200 0.7400 0.7600 0.7800 0.8000
0.8200 0.8400 0.8600 0.8800 0.9000
0.9200 0.9400 0.9600 0.9800 1.0000

****
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.
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****
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 02/14/2017 00:00:00
Ending Date 02/16/2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:15
Wet Time Step 00:00:05
Dry Time Step 00:00:15
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 4
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	2.330	118.196
Evaporation Loss	0.000	0.000
Infiltration Loss	0.555	28.147
Surface Runoff	1.767	89.669
Final Storage	0.007	0.380
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.767	17.673
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	1.767	17.673
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.000	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link CULVERT_02 (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
Block_K	118.20	0.00	0.00	65.77	52.23	1.24	0.10	0.442
External_01	118.20	0.00	0.00	65.92	52.09	0.11	0.01	0.441
External_02	118.20	0.00	0.00	65.92	52.09	0.06	0.00	0.441
External_03	118.20	0.00	0.00	65.92	52.09	2.37	0.18	0.441
External_04	118.20	0.00	0.00	65.66	52.35	0.54	0.04	0.443
S_001	118.20	0.00	0.00	0.11	117.48	0.35	0.02	0.994
S_002	118.20	0.00	0.00	0.11	117.48	1.15	0.05	0.994
S_003	118.20	0.00	0.00	0.11	117.48	0.85	0.04	0.994
S_004	118.20	0.00	0.00	0.11	117.48	1.35	0.06	0.994
S_005	118.20	0.00	0.00	0.11	117.48	1.59	0.07	0.994
S_006	118.20	0.00	0.00	0.11	117.48	0.83	0.04	0.994

S_007	118.20	0.00	0.00	1.95	116.21	1.60	0.07	0.983
S_008	118.20	0.00	0.00	0.11	117.47	1.93	0.08	0.994
S_009	118.20	0.00	0.00	0.11	117.48	0.58	0.03	0.994
S_010	118.20	0.00	0.00	0.11	117.48	0.54	0.02	0.994
S_011	118.20	0.00	0.00	12.87	105.32	0.42	0.02	0.891
S_013	118.20	0.00	0.00	0.11	117.48	0.43	0.02	0.994
S_014	118.20	511.58	0.00	0.11	629.05	1.52	0.11	0.999
S_14	118.20	0.00	0.00	0.11	117.48	0.44	0.02	0.994
S_2	118.20	0.00	0.00	0.11	117.48	1.00	0.04	0.994

****
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
Control_MH	JUNCTION	0.00	0.00	134.25	0 00:00	0.00
D_001	JUNCTION	0.01	0.07	138.07	0 08:00	0.07
D_002	JUNCTION	0.00	0.01	139.01	0 08:00	0.01
D_A001	JUNCTION	0.07	0.41	137.18	0 08:03	0.41
D_A003	JUNCTION	0.01	0.05	142.39	0 08:00	0.05
D_A004	JUNCTION	0.03	0.11	152.33	0 08:00	0.11
D_B001	JUNCTION	0.07	0.35	137.12	0 08:00	0.35
D_B003	JUNCTION	0.10	0.49	140.38	0 08:00	0.49
D_B004	JUNCTION	0.02	0.09	159.35	0 08:00	0.09
D_B005	JUNCTION	0.03	0.08	152.30	0 08:00	0.08
D_C001	JUNCTION	0.04	0.22	136.72	0 08:00	0.22
D_C002	JUNCTION	0.03	0.14	158.86	0 08:00	0.14
D_C003	JUNCTION	0.07	0.31	160.51	0 08:00	0.31
D_C004	JUNCTION	0.05	0.25	160.62	0 08:00	0.25
D_C005	JUNCTION	0.04	0.23	160.63	0 08:00	0.23
D_C006	JUNCTION	0.05	0.21	162.69	0 08:00	0.21
D_C007	JUNCTION	0.08	0.42	163.20	0 08:00	0.42
D_C008	JUNCTION	0.02	0.10	165.63	0 08:00	0.10
D_C009	JUNCTION	0.06	0.18	172.30	0 07:16	0.18
D_C010	JUNCTION	0.04	0.14	176.89	0 08:00	0.14
D_C011	JUNCTION	0.02	0.08	190.58	0 07:58	0.08
D_C012	JUNCTION	0.05	0.16	172.28	0 08:00	0.16
DO_001	JUNCTION	0.04	0.18	136.38	0 08:00	0.18
DO_002	JUNCTION	0.09	0.40	137.13	0 08:02	0.40
J1	JUNCTION	0.02	0.11	137.12	0 08:01	0.11
OF1	OUTFALL	0.00	0.00	132.25	0 00:00	0.00
SW_Pond	STORAGE	0.48	1.05	135.55	0 14:07	1.05

****
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
Control_MH	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
D_001	JUNCTION	0.053	0.053	0 08:00	1.11	1.11	-0.008
D_002	JUNCTION	0.005	0.005	0 08:00	0.0597	0.0597	-0.000

D_A001	JUNCTION	0.000	0.115	0	08:04	0	0.583	0.067
D_A003	JUNCTION	0.000	0.024	0	08:00	0	0.542	0.003
D_A004	JUNCTION	0.024	0.024	0	08:00	0.542	0.542	-0.001
D_B001	JUNCTION	0.000	0.199	0	08:00	0	4.54	0.005
D_B003	JUNCTION	0.020	0.201	0	08:00	0.424	4.54	0.029
D_B004	JUNCTION	0.155	0.155	0	08:00	3.53	3.53	-0.031
D_B005	JUNCTION	0.026	0.026	0	08:00	0.583	0.583	-0.064
D_C001	JUNCTION	0.000	0.517	0	08:00	0	10.2	0.001
D_C002	JUNCTION	0.019	0.460	0	08:00	0.437	9.05	0.000
D_C003	JUNCTION	0.130	0.441	0	08:00	1.96	8.61	-0.000
D_C004	JUNCTION	0.000	0.311	0	08:00	0	6.65	0.000
D_C005	JUNCTION	0.000	0.312	0	08:00	0	6.66	0.018
D_C006	JUNCTION	0.080	0.242	0	08:00	1.37	5.07	-0.011
D_C007	JUNCTION	0.000	0.162	0	08:00	0	3.7	0.053
D_C008	JUNCTION	0.037	0.097	0	08:00	0.851	2.2	-0.020
D_C009	JUNCTION	0.059	0.059	0	08:00	1.35	1.35	-0.008
D_C010	JUNCTION	0.050	0.066	0	08:00	1.15	1.5	-0.057
D_C011	JUNCTION	0.015	0.015	0	08:00	0.348	0.348	-0.012
D_C012	JUNCTION	0.070	0.070	0	08:00	1.59	1.59	-0.066
DO_001	JUNCTION	0.000	0.742	0	08:00	0	15.3	0.000
DO_002	JUNCTION	0.000	0.324	0	08:03	0	5.12	-0.007
J1	JUNCTION	0.000	0.024	0	07:59	0	0.542	-0.007
OF1	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
SW_Pond	STORAGE	0.182	0.921	0	08:00	2.37	17.7	-0.000

****
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
SW_Pond	2.927	25	0	100	6.595	55	0 14:07	0.175

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	0.00	0.000	0.000	0.000

System 0.00 0.000 0.000 0.000

****
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
C_01	CONDUIT	0.015	0	07:57	0.55	0.01	0.21
C_02	CONDUIT	0.066	0	08:00	1.40	0.03	0.56
C_03	CONDUIT	0.097	0	08:00	0.30	0.05	0.52
C_04	CONDUIT	0.059	0	08:00	1.17	0.05	0.29
C_05	CONDUIT	0.070	0	08:00	1.12	0.05	0.39
C_06	CONDUIT	0.242	0	08:00	0.77	0.19	0.44
C_07	CONDUIT	0.155	0	08:00	0.52	0.04	0.58
C_09	CONDUIT	0.026	0	07:59	1.59	0.01	0.57
C_10	CONDUIT	0.024	0	08:00	1.61	0.01	0.15
C_12	CONDUIT	0.460	0	08:00	1.87	0.09	0.36
C_13	CONDUIT	0.441	0	08:00	1.34	0.34	0.45
C_14	CONDUIT	0.311	0	08:00	0.57	0.12	0.40
C_15	CONDUIT	0.053	0	08:00	0.39	0.03	0.29
C_16	CONDUIT	0.005	0	08:00	0.03	0.00	0.23
C_INLET_01	CONDUIT	0.740	0	08:00	1.76	0.16	0.36
CULVERT_01	CONDUIT	0.199	0	08:00	1.20	0.65	0.80
CULVERT_02	CONDUIT	0.162	0	08:00	1.30	0.56	0.60
CULVERT_03	CONDUIT	0.311	0	08:00	0.61	0.06	0.31
CULVERT_04	CONDUIT	0.516	0	08:00	0.72	0.05	0.22
OUTLET_01	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
STM_01	CONDUIT	0.024	0	07:59	2.79	0.07	0.29
STM_02	CONDUIT	0.037	0	08:04	0.60	0.08	0.48
STM_03	CONDUIT	0.113	0	08:04	0.72	0.28	0.74
STM_04	CONDUIT	0.212	0	08:02	1.32	0.47	0.72
STM_05	CONDUIT	0.226	0	08:01	1.92	0.75	0.55
W1	WEIR	0.000	0	00:00		0.00	

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Up Dry	Down Dry	Sub Dry	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C_01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_02	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_03	1.00	0.00	0.05	0.00	0.95	0.00	0.00	1.00	0.00
C_04	1.00	0.00	0.00	0.00	0.37	0.63	0.00	0.00	0.00
C_05	1.00	0.00	0.00	0.00	0.46	0.54	0.00	0.19	0.00
C_06	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.51	0.00
C_07	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
C_09	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.99	0.00
C_10	1.00	0.00	0.00	0.00	0.42	0.58	0.00	0.00	0.00
C_12	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.51	0.00
C_13	1.00	0.00	0.00	0.00	0.98	0.02	0.00	0.00	0.00
C_14	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.12	0.00

C_15	1.00	0.00	0.11	0.00	0.88	0.00	0.00	0.00	0.99	0.00
C_16	1.00	0.00	0.42	0.00	0.58	0.00	0.00	0.00	1.00	0.00
C_INLET_01	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
CULVERT_01	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.57
CULVERT_02	1.00	0.00	0.00	0.00	0.57	0.43	0.00	0.00	0.00	0.53
CULVERT_03	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
CULVERT_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
OUTLET_01	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STM_01	1.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.50	0.00
STM_02	1.00	0.00	0.22	0.00	0.77	0.01	0.00	0.00	0.97	0.00
STM_03	1.00	0.00	0.00	0.00	0.59	0.00	0.00	0.40	0.08	0.00
STM_04	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.49	0.00
STM_05	1.00	0.00	0.00	0.00	0.36	0.64	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Sep 20 15:54:41 2017
Analysis ended on: Wed Sep 20 15:54:46 2017
Total elapsed time: 00:00:05

Attachment D
Product Specifications

Motz Enterprises, Inc.
11006 Reading Road
Suite 301
Cincinnati OH 45241
Office: 513-772-6689
Fax: 513-772-6690
www.Flexamat.com

Product Data Sheet

Flexamat® is a tied concrete block mat used to control erosion in swales, slopes, ditches, channels, shorelines and any area where soil sediment may be lost due to water runoff.

Flexamat® should be considered in any application where consideration is being given to poured concrete, riprap, gabions, ACB's and other hard-armor systems.

Flexamat® consists of pyramidal concrete blocks that are interconnected utilizing a rough-service polyester geogrid. The completed mat yields a high strength, ultra-flexible hard armor system of Erosion Control. Flexamat's superior Percentage of Open Area (POA) affords an ideal zone for vegetation growth while remaining a permanent armor against long-term erosional forces.

General Composition of Materials

Blocks	5000 PSI, Wet-cast Portland Cement
Interlocking Geogrid	Fornit 30/30
Underlayment Options	Curlex II TRM Recyclex-V TRM Non-woven fabrics More options available

Manufacturing Values

Flexamat Properties	Values
Roll Width	4', 5.5', 8', 10', 12' 16'
Roll Length	30', 40', 50' / custom
Material Weight	11 lbs./sf
Block Size	6.5" x 6.5" x 2.5"

Performance Design Criteria

Percentage Open Area (POA)	30% min.
Geogrid Tensile Strength	2000 lbs./lf min.
Shear Tolerance*	24 lbs./sf
Velocity Tolerance*	19ft./s

*ASTM D 6460

Appendix F
HELP Model Inputs and Outputs

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


PRECIPITATION DATA FILE:    C:\HELP3\56484PB.D4
TEMPERATURE DATA FILE:      C:\HELP3\56484TB.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\56484SRB.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\56484ETB.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\56484DCP.D10
OUTPUT DATA FILE:           C:\HELP3\56484dcp.OUT


TIME:  11:38     DATE:  10/31/2017


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

     TITLE:  CRWMC DOCP Update - Daily Cover Plateau

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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   5
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2382 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	6000.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3018	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	200.00	CM
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2660	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 40. METERS.

SCS RUNOFF CURVE NUMBER	=	84.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	20.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.038	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.210	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.255	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	1867.699	CM
TOTAL INITIAL WATER	=	1867.699	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	50.00 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	20.0 CM
AVERAGE ANNUAL WIND SPEED	=	9.45 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	85.27 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.65 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	68.67 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	88.03 %

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
234.1	160.4	148.0	101.2	72.1	62.8
41.9	49.5	59.3	181.3	257.1	250.7

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.8	3.7	5.8	8.5	11.9	14.9
17.3	17.4	14.1	9.2	4.9	2.6

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 0.50 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	232.48	155.49	150.70	112.25	70.94	62.03
	39.71	43.54	56.60	187.62	243.96	259.68
STD. DEVIATIONS	68.16	51.93	49.16	41.66	35.64	32.50
	30.12	33.58	32.30	76.86	82.28	77.17
RUNOFF						
TOTALS	71.853	45.048	9.519	2.153	0.901	0.636
	0.827	1.094	0.526	16.703	27.628	41.841
STD. DEVIATIONS	90.644	75.327	26.455	3.377	2.177	1.348
	1.898	4.214	1.378	17.694	23.231	52.750
EVAPOTRANSPIRATION						
TOTALS	6.787	11.535	37.904	72.879	64.609	52.948
	36.775	32.322	39.563	23.138	8.953	6.009
STD. DEVIATIONS	2.645	4.380	6.219	11.669	21.123	22.419
	22.539	21.855	18.946	4.624	1.723	2.098
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	43.7591	46.4433	61.0659	64.0253	104.7650	122.3367
	122.1665	117.9215	108.4697	103.1453	61.2010	43.0337
STD. DEVIATIONS	18.2165	25.4327	25.8237	24.7126	26.8899	18.1114
	15.4214	13.1555	13.6626	12.5341	13.5967	12.1366

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

	MM		CU. METERS	PERCENT
PRECIPITATION	1615.00	(207.735)	16150.0	100.00
RUNOFF	218.728	(151.6685)	2187.28	13.544
EVAPOTRANSPIRATION	393.422	(55.5537)	3934.22	24.360
PERCOLATION/LEAKAGE THROUGH LAYER 3	998.33282	(101.74606)	9983.328	61.81609

CHANGE IN WATER STORAGE	4.522	(8.8974)	45.22	0.280

****

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	142.90	1429.000
RUNOFF	109.458	1094.5753
PERCOLATION/LEAKAGE THROUGH LAYER 3	8.044525	80.44525
SNOW WATER	394.15	3941.5271

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4510
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0627

****

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.0881	0.2059
2	1844.5159	0.3074
3	65.3144	0.3266
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\56484PB.D4
TEMPERATURE DATA FILE:      C:\HELP3\56484TB.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\56484SRB.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\56484ETB.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\56484ICP.D10
OUTPUT DATA FILE:           C:\HELP3\56484icp.OUT

TIME:  11:59     DATE:  10/31/2017

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     TITLE:  CRWMC DOCP Update - Intermediate Cover Plateau

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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   5
          THICKNESS                    =     30.00   CM
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2389 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	6000.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3017	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	200.00	CM
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2673	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 40. METERS.

SCS RUNOFF CURVE NUMBER	=	84.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	20.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.723	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.140	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.160	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	1870.792	CM
TOTAL INITIAL WATER	=	1870.792	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	50.00 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	20.0 CM
AVERAGE ANNUAL WIND SPEED	=	9.45 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	85.27 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.65 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	68.67 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	88.03 %

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
234.1	160.4	148.0	101.2	72.1	62.8
41.9	49.5	59.3	181.3	257.1	250.7

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.8	3.7	5.8	8.5	11.9	14.9
17.3	17.4	14.1	9.2	4.9	2.6

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 0.50 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	232.48	155.49	150.70	112.25	70.94	62.03
	39.71	43.54	56.60	187.62	243.96	259.68
STD. DEVIATIONS	68.16	51.93	49.16	41.66	35.64	32.50
	30.12	33.58	32.30	76.86	82.28	77.17
RUNOFF						
TOTALS	72.620	45.525	9.749	2.252	0.916	0.664
	0.838	1.100	0.543	17.129	28.269	42.500
STD. DEVIATIONS	91.016	75.638	26.663	3.488	2.188	1.396
	1.927	4.236	1.392	18.012	23.564	52.965
EVAPOTRANSPIRATION						
TOTALS	6.788	11.536	37.702	70.750	61.896	50.801
	35.069	30.420	37.801	22.844	8.958	6.010
STD. DEVIATIONS	2.646	4.379	6.120	11.873	20.752	21.683
	21.716	21.189	18.649	4.766	1.725	2.099
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	43.6739	46.3792	61.9070	64.0710	103.0918	122.7937
	123.4082	119.4438	110.6907	105.4277	62.9109	43.3944
STD. DEVIATIONS	17.1438	25.5592	26.3148	25.3173	27.7400	18.2039
	16.6780	13.8792	13.9057	13.0303	14.6349	12.2628

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

	MM		CU. METERS	PERCENT
PRECIPITATION	1615.00	(207.735)	16150.0	100.00
RUNOFF	222.106	(152.3327)	2221.06	13.753
EVAPOTRANSPIRATION	380.576	(53.9719)	3805.76	23.565
PERCOLATION/LEAKAGE THROUGH LAYER 3	1007.19220	(105.20267)	10071.922	62.36466

CHANGE IN WATER STORAGE	5.131	(9.0125)	51.31	0.318

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	142.90	1429.000
RUNOFF	109.539	1095.3872
PERCOLATION/LEAKAGE THROUGH LAYER 3	8.348610	83.48610
SNOW WATER	394.15	3941.5271

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4239
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0580

****

****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	6.5521	0.2184
2	1850.6661	0.3084
3	64.8813	0.3244
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\56484PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\56484TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\56484SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\56484ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\56484FCP.D10
OUTPUT DATA FILE:           C:\HELP3\56484fcp.OUT


TIME:  12:21     DATE:  10/31/2017


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     TITLE:  CRWMC DOCP Update - Final Cover Plateau

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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   =      0.1932 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 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	60.00	CM
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2640	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0603	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	5.00	PERCENT
DRAINAGE LENGTH	=	40.0	METERS

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

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.	=	0.399999993000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	30.00	CM
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1310	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	6000.00	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 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	200.00	CM
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1310	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-04	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 5.% AND A SLOPE LENGTH OF 40. METERS.

SCS RUNOFF CURVE NUMBER	=	54.30	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	20.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.098	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.840	CM

LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.995	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	1800.906	CM
TOTAL INITIAL WATER	=	1800.906	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	50.00	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	20.0	CM
AVERAGE ANNUAL WIND SPEED	=	9.45	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	85.27	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.65	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	68.67	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	88.03	%

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
234.1	160.4	148.0	101.2	72.1	62.8
41.9	49.5	59.3	181.3	257.1	250.7

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.8	3.7	5.8	8.5	11.9	14.9
17.3	17.4	14.1	9.2	4.9	2.6

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 0.50 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	232.48	155.49	150.70	112.25	70.94	62.03
	39.71	43.54	56.60	187.62	243.96	259.68
STD. DEVIATIONS	68.16	51.93	49.16	41.66	35.64	32.50
	30.12	33.58	32.30	76.86	82.28	77.17
RUNOFF						
TOTALS	50.994	35.401	4.847	0.000	0.000	0.000
	0.000	0.001	0.000	0.009	0.252	15.379
STD. DEVIATIONS	93.111	76.701	26.825	0.000	0.000	0.000
	0.000	0.012	0.000	0.039	1.296	50.849
EVAPOTRANSPIRATION						
TOTALS	6.582	11.105	36.720	69.215	60.513	51.196
	33.997	32.533	37.735	19.784	7.689	5.611
STD. DEVIATIONS	2.421	4.078	5.892	12.550	22.312	23.110
	22.992	20.784	18.873	4.499	1.554	1.844
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	192.5743	133.6438	122.4565	65.9076	27.9057	16.0902
	12.7357	10.2512	10.8220	115.8101	215.3286	211.7664
STD. DEVIATIONS	89.8896	63.7621	49.5191	32.4757	15.4374	13.1216
	9.2928	12.0958	12.8908	70.7227	78.5868	86.8716
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0252	0.0186	0.0182	0.0113	0.0060	0.0039
	0.0033	0.0028	0.0027	0.0159	0.0300	0.0284
STD. DEVIATIONS	0.0099	0.0073	0.0058	0.0041	0.0024	0.0021
	0.0016	0.0019	0.0022	0.0081	0.0199	0.0133
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0037	0.0043	0.0048	0.0073	0.0095	0.0078
	0.0057	0.0038	0.0028	0.0026	0.0026	0.0029

STD. DEVIATIONS	0.0025	0.0028	0.0026	0.0024	0.0029	0.0045
	0.0053	0.0049	0.0044	0.0024	0.0015	0.0019

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0305	0.0222	0.0183	0.0102	0.0042	0.0025
	0.0019	0.0015	0.0017	0.0188	0.0473	0.0383
STD. DEVIATIONS	0.0170	0.0110	0.0074	0.0050	0.0023	0.0020
	0.0014	0.0018	0.0020	0.0137	0.0872	0.0431

****

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

	MM		CU. METERS	PERCENT
PRECIPITATION	1615.00	(207.735)	16150.0	100.00
RUNOFF	106.884	(153.8041)	1068.84	6.618
EVAPOTRANSPIRATION	372.681	(54.7799)	3726.81	23.076
LATERAL DRAINAGE COLLECTED FROM LAYER 3	1135.29187	(199.55598)	11352.919	70.29650
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.16633	(0.03022)	1.663	0.01030
AVERAGE HEAD ON TOP OF LAYER 4	0.164	(0.083)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.05773	(0.01462)	0.577	0.00357
CHANGE IN WATER STORAGE	0.090	(2.8919)	0.90	0.006

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	142.90	1429.000
RUNOFF	109.558	1095.5836
DRAINAGE COLLECTED FROM LAYER 3	89.34155	893.41547
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.109268	1.09268
AVERAGE HEAD ON TOP OF LAYER 4	155.961	
MAXIMUM HEAD ON TOP OF LAYER 4	208.974	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	7.5 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000392	0.00392
SNOW WATER	394.15	3941.5271

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4375
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0497

*** 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	2.5060	0.1671
2	16.0447	0.2674
3	0.0325	0.0649
4	0.0000	0.0000
5	3.9300	0.1310
6	1752.0001	0.2920
7	27.2953	0.1365
SNOW WATER	0.000	

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Appendix G
Landfill Gas (LFG) Management Facilities Design Plan

Draft for Review

This document is in draft form. A final version of this document may differ from this draft. As such, the contents of this draft document shall not be relied upon. GHD disclaims any responsibility or liability arising from decisions made based on this draft document.



Updated Landfill Gas Management Facilities Design Plan

Campbell River Waste Management Centre

Comox Valley Regional District

GHD | 10271 Shellbridge Way Suite 165 Richmond British Columbia V6X 2W8 Canada

056484 | 200 | 02 | Report No 31 | June 13 2017

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   - 3.3 Collection Field Development 4
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Drawing GN-01 Cover Page

Drawing C-01 Landfill Gas Collection Layout

Drawing C-02 LFG Details (1 of 2)

Drawing C-03 LFG Details (2 of 2)

Drawing C-04 Landfill Gas Flare System Compound and Fence Details

Drawing M-01 Condensate Trap Details

Table Index

Table 2.1 Results of Landfill Gas Generation Modelling 2

Table Index (Following Text)

Table 1.1 Design Standards Compliance

Appendix Index

Appendix A Updated LFG Generation Assessment

1. Introduction

GHD Limited (GHD) has prepared the following report entitled, “Updated Landfill Gas Management Facilities Design Plan” for the Campbell River Waste Management Centre (CRWMC or Site) on behalf of the Comox Valley Regional District (CVRD).

This Updated Landfill Gas Management Facilities Design Plan (Plan) has been prepared to meet Section 7(2) of the "*Landfill Gas Management Regulation*" (Regulation), with consideration to the "*Landfill Gas Management Facilities Design Guidelines*" (Guidelines) (CRA, 2010). For the purpose of this plan and conformance with Section 7(2)(f) of the Regulation, Deacon Liddy, P. Eng., is the qualified professional.

This Plan has been organized to meet the requirements of the Landfill Gas (LFG) Management Facility Design Guidelines as follows:

- Section 2.0 - Site Conditions and Design Objectives
- Section 3.0 - Existing Landfill Gas Management Facilities
- Section 4.0 - Planned Landfill Gas Management System Upgrades
- Section 5.0 - System Optimization
- Section 6.0 - Additional Information

The construction of the LFG Management Facilities will follow the placement of the final cover for the CRWMC. The construction of the LFG management Facilities following the placement of the final cover is favorable due to the following:

- Prior to the landfill closure, the LFG collection field will be able to capture LFG from a footprint of approximately 29,500 square metres, which would result in high operational costs and down time.
- The potential LFG collection footprint prior to landfill closure, in the outer areas of the limit of waste, would be in the older waste relative to the centre of the limit of waste.
- Following the landfill closure, the LFG collection field will be able to capture LFG from a footprint of approximately 60,900 square metres.
- Until the final cover is placed, air intrusion would be expected if the LFG Extraction Plant places a strong vacuum on the collection field.
- The Comox Valley Waste Management Centre LFG management facilities are currently in the commissioning phase until installation of the final cover to reach the expected recovery rates.
- Reaching the target of 75 percent design recovery collection efficiency will not be able to be reached until the final cover is placed.

2. Site Conditions and Design Objectives

The CRWMC is located approximately 6.5 kilometres (km) east of the city of Campbell River, British Columbia (BC), on Argonaut Road. The Site is owned by the CVRD and operated by Berry and Vale under contract with the CVRD. The authorized works include the municipal solid waste landfill and related appurtenances.

The landfill currently operates under OC MR-02401, issued on December 2, 2003. OC MR-0240 replaced the original permit, which was issued in November 1973 and last amended in July 1992. Refuse authorized for disposal at the Site is characterized as “municipal solid waste as defined under the Waste Management Act”.

The Site is located within the city limits of Campbell River, BC on Argonaut Road approximately 7.5 kilometres (km) east of the city centre. The Site is composed of two land parcels, Blocks C and J within District Lot 85 of the Sayward Land District. The total Site area is 29.7 hectares. The Site is currently zoned as Industrial Four (I-4) under the City of Campbell River Bylaw No. 3250. The property directly west of Block C is owned by Island Ready Mix and houses operations and equipment for concrete manufacturing and a gravel pit. Directly south of the Site is a gravel pit. Mature forests situated on Crown Land are located to the north and east of the Site. There are three residential dwellings located approximately 500 meters (m) to the northeast of the landfill footprint.

The property immediately to the east of Block J is occupied by a single dwelling residential lot. There are also several active and historical industrial operations in the vicinity of the landfill. Active industrial operations include an auto scrap yard, two construction landfills, and an asphalt paving plant and an Emcom facility which includes a salt storage shed. Historical operations in the vicinity include a crane operation which housed facilities for cleaning copper coated fish farm nets and a metal scrap yard.

According to CH2MHILL’s 2009 closure plan, the Site operated as an informal dump site prior to the 1970s. Waste burning took place at the Site as well as disposal of liquid wastes (EBA, 2014). Prior to landfilling at the Site, the Site operated as an aggregate extraction facility. The City of Campbell River took over Site operations in the mid 1970s until ownership was transferred to the CVRD in 1999 (EBA, 2014). A private contractor, Berry and Vale, has operated the Site under contract with the CVRD since 1996.

A report titled Landfill Gas Generation Assessment for the CRWMC (CRA, 2010) was submitted to the MOE. The LFG generation rate was updated by GHD for this report to reflect more recent projections of future waste disposal rates, and corresponding changes in future LFG generation. The updated projections of future LFG generation are provided in Appendix A and are summarized in Table 2.1.

Table 2.1 Results of Landfill Gas Generation Modelling

Year	Annual Waste Disposal Rate	Projected Landfill Gas Generation (m^3/hr)
2012	25,698	482.5
2013	26,992	492.4
2014	28,373	504.2

Table 2.1 Results of Landfill Gas Generation Modelling

Year	Annual Waste Disposal Rate	Projected Landfill Gas Generation (m^3/hr)
2015	25,303	508.9
2016	25,490	513.6
2017	26,371	519.6
2018	26,506	525.5
2019	26,409	530.7
2020	26,016	534.7

The annual LFG generation in cubic metres per hour can be approximately converted to an annual average tonnage of methane (tonnes of methane per year) by multiplying the modelled LFG generation in cubic metres per hour by a factor of 2.89 (e.g., 519.6 m^3/hr of LFG at 50% methane is approximately equal to an annual average of 1,502 tonnes of methane per year at a standard temperature of 20°C).

Health and safety safeguards for LFG migration and for LFG control will include on-Site and off-Site gas monitoring wells, monitoring locations beneath nearby off-Site structures, and periodic monitoring of these locations for methane content. The typical LFG probe designs are presented on Drawing C-03.

3. Landfill Gas Management Facilities Design

The following section presents a description of the planned methods, management practices, and processes for landfill gas management at the landfill site as required under Sections 7(2)(a) of the Regulation.

3.1 Design Considerations

The following provides a summary of the information reviewed and pertinence to the conceptual design of the LFG collection system:

Information/Data Input	Design Considerations
Fill Plan – The closure of the landfill is scheduled to take place in 2023.	By constructing the LFG collection system during the landfill closure, the collection system will be installed as one construction project. The LLDPE final cover will be installed over the surface of the landfill during the same closure construction contract.
MSE Wall- Presence of lock Block MSE (mechanically stabilized earth) Wall on eastern edge of landfill.	Presents a potential path for air intrusion if wells are placed in close proximity. Wells will be placed at a horizontal distance of 25 metres or greater from the MSE Wall.

A design standards compliance checklist is included in Table 1.1 following the text.

3.2 Conceptual Design Assumptions

LFG collection system conceptual designs were generated for implementation during the final closure of the landfill. For the purpose of this report, the following general design elements were included:

- Pipe network to be composed of buried High Density Polyethylene (HDPE) pipe
- Vertical collection wells to have a collection radius of 25 metres (greater than 25 metres away from the MSE wall)
- Valve chambers comprising flow control and sample port assemblies
- Single centrifugal blower with variable frequency drive
- Condensate knockout/moisture separator at the flare station
- Two condensate traps each with an adjacent condensate storage tank
- Gas probes installed in more permeable strata between the landfill footprint and the property boundary
- LFG plant will be skid mounted with blower/motor units and all instrumentation
- LFG instrumentation to include flow meter, pressure and temperature gages, and LFG gas sensors (methane and oxygen)
- Programmable logic controller
- Flare Stack Thermocouple
- Datalogger/ autodialer

3.3 Collection Field Development

The LFG Generation Assessment (CRA, 2010) identified that the Site is required to install a LFG management system as per the LFG Regulation.

GHD's proposed conceptual design is based on a vertical well network in the landfill area of the Site (Drawing C-01). It is envisioned that construction of this network will include construction of the LFG control plant, enclosed flare, and approximately 31 vertical collection wells with approximately 2,300 m of collection pipe. The collection system will be designed to capture all of the landfill gas generated, which is equivalent to approximately 1,500 tonnes of methane per year. Details of the installation of the collection field wells, underground piping, and chambers are included in Drawing C-02 and Drawing C-03.

The use of vertical collection wells is favourable over the use of horizontal collection trenches as the wells will be able to collect gas generated at the deeper levels of the landfill and the wells can all be installed at closure. The collection wells will also be easier to construct as it will not involve the excavation of trenches into the waste mass. Due to the pyramid type shape of the landfill and limited working area, installing horizontal trenches would be difficult to integrate with operations.

The LFG collection system will be installed as part of the final closure of the landfill, so no further expansion of the wellfield will occur.

3.4 Header Piping

A 200 mm diameter HDPE header pipe will be installed on the north and west perimeter of the landfill, and along the south and east side slope of the landfill. The subheader piping will be 150 mm diameter HDPE pipe and will connect to the vertical LFG collection wells.

3.5 Condensate Management

Condensate traps will be placed at the low points in the LFG collection system header piping. One condensate trap will be placed at the entrance to the blower/flare station and another will be placed at the northeast termination of the two header pipes.

The two condensate traps will allow for collected condensate to gravity drain into an underground concrete tank. The tanks will have a level logger which will allow for a signal to the landfill post-closure operator to empty the storage tank. After the condensate trap is drained, the condensate will be disposed of at either the City of Campbell River Waste Water Treatment Plant or the future Comox Leachate Treatment Facility. Details of the condensate trap installation are included in Drawing M-01.

3.6 Landfill Gas Extraction Plant

A layout of the LFG Extraction Plant skid is presented in Drawing C-04. The LFG Extraction Plant will include the following features:

- Condensate trap ('p' trap) connected to a storage tank
- Condensate knockout pot
- LFG Analyzer (O_2 and CH_4)
- Blower with a capacity of 100 m^3/hr to 500 m^3/hr
- Pressure gauges
- Flow meter
- Flame Arrestor
- Flare stack thermocouple
- Enclosed Flare with a maximum capacity of 500 m^3/hr

3.7 Flaring

Two types of flares are typically used at LFG extraction plants 1) candlestick type flares or 2) enclosed flares. Candlestick type flares typically range in cost from $30,000 to $60,000, whereas small enclosed flares typically range in cost from $175,000 to $200,000. Candlestick type flares are commonly used in conjunction with utilization facilities as backup during maintenance and breakdowns or when LFG collection exceeds the capacity of the utilization system. Candlestick type

flares offer a low-cost method of disposing LFG; however, the destruction efficiency of candlestick flares is lower than enclosed flares. Enclosed flares are often used at sites where utilization is not viable. They are designed to achieve a specified combustion temperature and retain exhaust gases at that temperature for a specified time to ensure a maximum degree of destruction of contaminants is achieved.

Until a feasibility study is completed, it is unknown whether utilization will be a viable option for the Site.

Should an enclosed flare be installed, it shall meet the requirements of Design Standard 8. As such, it must be designed to have a minimum retention time of 0.5 seconds and a minimum flare temperature of 875 degrees Celsius. To ensure safe operations, it must be equipped with the following features:

- Flame arrestor
- Electronic ignition system
- Flame sensors/scanners
- Automated modulation and shut-off valves
- Temperature sensors/thermocouples
- Electronic interlocks to shut the system down under fault conditions

All of the above are typical features of an enclosed flare.

3.8 LFG Utilization Equipment

Selecting an option for utilization is dependent on a number of factors, including energy or product sales prices, capital and operating costs, and proximity to infrastructure such as electricity or natural gas transmission. Electricity generation is often favoured because the basic equipment is readily available and the economics are favourable. Electricity generation can be achieved with low- and medium-grade LFG using a variety of technologies and with minimal pre-treatment.

For high-grade applications, such as the generation of natural gas or direct use, pre-treatment requirements increase considerably, as do the costs for this level of processing.

Primary constituents in LFG requiring pre-treatment include the following:

- Free moisture/water vapour
- Particulates
- Hydrogen sulphide
- Siloxanes
- Halogenated organic compounds
- Carbon dioxide

Relative amounts of these compounds must be ascertained on a site-specific basis through testing, and it is recommended that such testing be undertaken prior to selecting a utilization option.

Should utilization prove to be a viable option, the utilization plant would be located adjacent to the proposed location for the flare compound, south west of the landfill.

4. System Installation, Operation, and Maintenance

The following section presents a plan for installation, operation, and maintenance of landfill gas management facilities at the landfill site.

4.1 Installation and Commissioning

Newly installed LFG extraction points will be commissioned through the following procedure:

- Measure pressure on wellhead side of extraction point valve.
- If pressure is positive then open valve to target an initial vacuum of 10 inches of water column on the landfill side of the valve. Measure and record oxygen content, methane content, carbon dioxide, and balance concentrations and the vacuum pressure on the blower-flare station side of the valve. If oxygen above 0.5 percent is detected immediately adjust the valve to reduce the vacuum pressure until oxygen concentrations fall below 0.5 percent. If the methane content is 35 percent or higher and flow is present within the well, adjust the valve to increase until the oxygen content begins to reach 0.5 percent.
- Return to the extraction point within 4-8 hours and measure the oxygen content of the LFG. If the oxygen content is above 0.5 percent reduce the pressure on the landfill side of the valve to achieve an oxygen content below 0.5 percent.
- Continue to balance the new wells points daily for a week.
- At the end of the first week a full balancing of the active portions of the LFG collection system will be required. The valves on existing wells may need to be opened slightly to maintain a similar vacuum to before the addition of the new extraction points.
- At the end of the first week balance the entire system once per week for the first month.
- At the end of the first month, return to monthly balancing of the LFG collection system.

4.2 Operation

The operation of a LFG collection system generally needs to meet the following performance standards:

- Oxygen content should not exceed 2 percent by volume and nitrogen should not exceed 15 percent by volume at a LFG extraction well. Generally oxygen and nitrogen are below both concentrations for active LFG extraction wells at the Site.
- Methane content, oxygen content, carbon dioxide content, nitrogen content, and vacuum and valve position must be measured at all monitoring ports at all wells at least on a monthly basis.
- If the LFG analyzer detects high oxygen concentrations (greater than 2 percent by volume), a round of field monitoring and balancing must be initiated as soon as practically possible.

4.3 Maintenance

An operation and maintenance plan should be developed as part of the installation of the LFG management facility.

General maintenance will include the following:

- Weekly operations checks
- Monthly well balancing
- Monthly blower/flare station inspection
- Quarterly flow meter and LFG analyzer check
- Annual well head assembly inspection
- Annual blower/flare station inspection
- Annual blower/motor alignment check
- Annual flow meter and LFG analyzer maintenance and calibration

5. System Optimization

Routine and scheduled monitoring and adjustment of the LFG collection field is required to optimize the effectiveness of the collection system in response to varying LFG generation rates; this activity is generally called well field balancing. A well designed, constructed, and operated LFG recovery system can collect 75 percent or more of the LFG at a landfill site. It is important for a collection system to be operated to match the site's changing LFG generation potential without over or under-drawing on the collection field. In addition to the changing LFG generation rate over the life of the landfill, the effective LFG generation rate also varies somewhat over the short term as a function of factors such as meteorological conditions, differential settlement, equipment efficiencies, and cover system conditions.

The LFG collection field must be routinely monitored and adjusted to optimize the effectiveness of the collection system. The adjustment of valve settings to reduce or increase LFG flows from low or high generation areas of the landfill is required to maximize LFG collection without overdrawing from those areas of the site that may be susceptible to air intrusion. It should be noted that collection field adjustments must be made based upon a review of historic well or trench performance considered within the context of the overall field operation. Even relatively minor changes to a particular collection point will influence flow, vacuum, and gas quality at other locations within the collection system.

A certain amount of judgment gained from site-specific experience is required when making adjustments to the collection field. If LFG readings at a specific well are found to be substantially below the LFG concentration at the LFG Collection Plant, then the flow from that well should be reduced. Wholescale changes in the valve position (i.e., going from fully open to fully closed) are often counter-productive, as a given well may demonstrate high oxygen/low methane at full vacuum exertion, but reasonable gas quality at some reduced level; this reflects the purpose of well control

valves. Smaller changes in valve position are more conducive to effective operations, and are most useful when the history of a well relative to LFG quality and valve position are recorded and utilized to guide future balancing activities.

6. Additional Information

As required under Sections 7(2)(e) of the Regulation the LFG Management Facilities Design Plan is required to contain any other information requested in writing by the director. No additional information has been requested by the director in writing.

Table 1.1

Design Standards Compliance
Updated Landfill Gas Management Facilities Design Plan
Campbell River Waste Management Centre
Comox Valley Regional District

Standard #	Landfill Gas Management Facilities Design Guidelines	CRWMC Landfill Gas Management Facility Design Plan
Design Standard 1	The results of the LFG generation assessment conducted in accordance with the Regulation will provide the basic inputs to design the LFG management system.	The LFG generation assessment results were used to size the LFG collection system piping.
Design Standard 2	It is expected that LFG management systems must be designed to maintain 75 percent collection efficiency.	The LFG collection system has been designed to target a LFG collection efficiency of 75 percent.
Design Standard 3	All regulated landfills are required to design and install active LFG collection systems to collect LFG as per the BC MOE Regulation requirements.	The design plan presents a design that complies with the BC MOE Regulation requirements.
Design Standard 4	LFG management systems will be designed to accommodate the maximum LFG generation expected, rather than the expected LFG collection.	The LFG collection system has been designed to accommodate all the of LFG generated from the landfill based on the LFG generation assessment results.
Design Standard 5	All LFG captured must undergo a reduction in global warming potential as it relates to the methane component of the gas (i.e. flaring, LFG utilization for electricity generation, fuel for vehicles).	The primary destruction device at the CRWMC will be an enclosed drum flare (or utlization in the future).
Design Standard 6	An active LFG collection system is required to include a complete LFG extraction control plant on-site with a LFG flare. If flaring will be the primary methane destruction device, an enclosed high-efficiency flare will be utilized. A candlestick flare may be utilized as the backup system to a LFG utilization system, or may be used when there is a surplus of LFG collected (above the capacity of the utilization system). However, where a utilization system is in place and a candlestick flare is used as backup, the candlestick flare will not be the primary combustion device.	The primary destruction device at the CRWMC will be an enclosed drum flare (or utlization in the future).
Design Standard 7	LFG flow rate (in m^3/hr or equivalent), methane composition (in percent by volume), oxygen content (in percent by volume) and flare stack temperature (in degrees Celsius) must be measured on a continuous basis with ongoing logging of all data on an aggregated period of not less than every five minutes.	A datalogger will be installed to monitor each of these parameters.
Design Standard 8	An enclosed flare must be designed to have a minimum retention time of 0.5 seconds and a minimum flare temperature of 875 degrees Celsius.	The primary destruction device at the CRWMC will be an enclosed drum flare.
Design Standard 9	Landfill owners and operators must develop an Operations and Maintenance Manual for the LFG management systems.	An LFG operations and maintenance manual will be developed.
Design Standard 10	All buildings on the landfill site must have continuous combustible gas measurement equipment.	The LFG management system buildings will have continuous gas measurement equipment.

Drawings

CAMPBELL RIVER WASTE MANAGEMENT CENTRE
CAMPBELL RIVER, BRITISH COLUMBIA
LANDFILL GAS DESIGN PLAN

56484-200

SOURCE:
JANUARY 01, 2007. GOVERNMENT OF CANADA, NATURAL RESOURCES CANADA.



AREA MAP

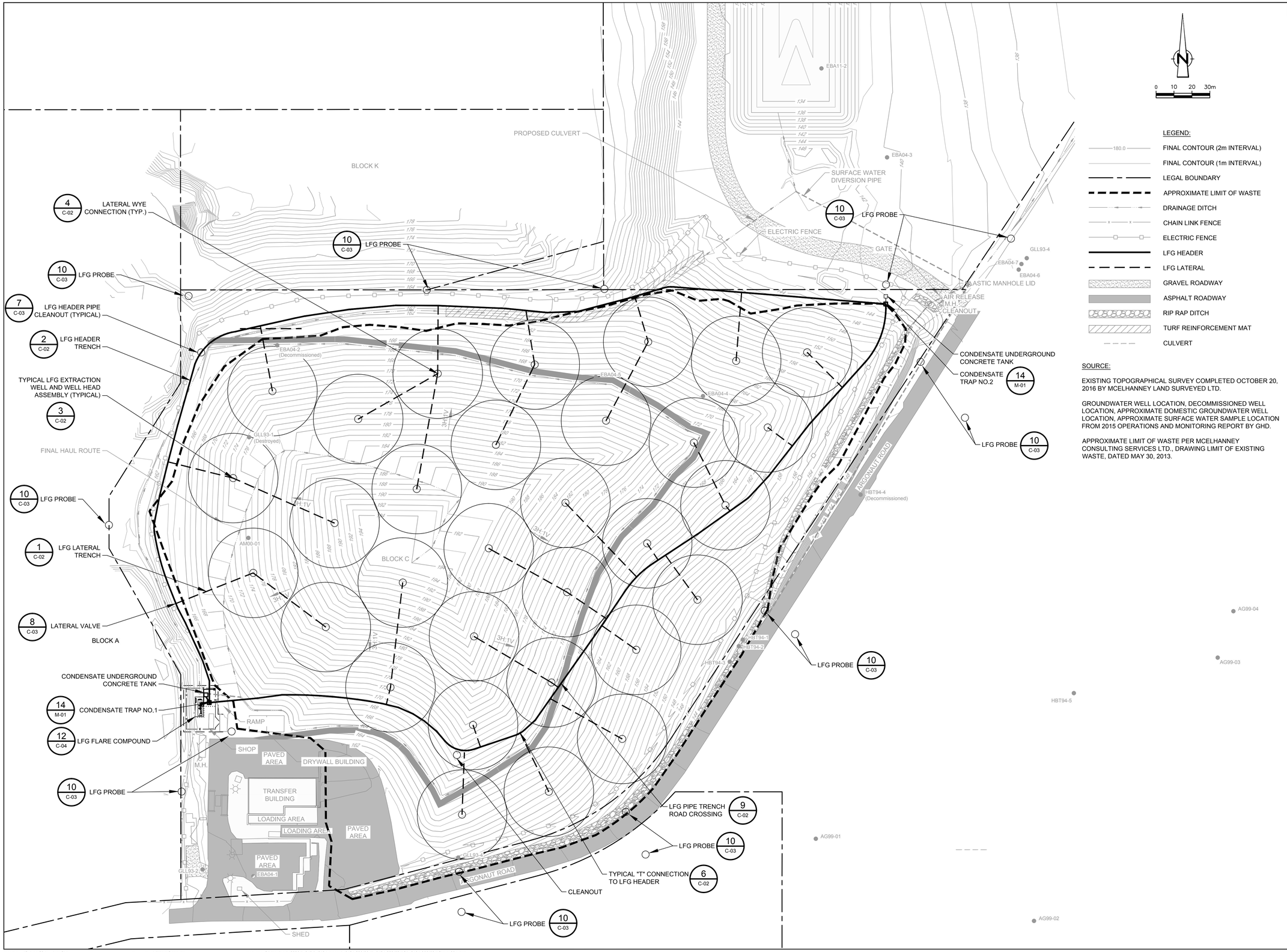
SOURCE:
BING IMAGERY: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION



SITE MAP

DRAWING INDEX

DWG NO.	REV NO.	DATE	TITLE
C-01	0	JUNE 2017	COLLECTION SYSTEM LAYOUT
C-02	0	JUNE 2017	LFG COLLECTION SYSTEM DETAILS (1 OF 2)
C-03	0	JUNE 2017	LFG COLLECTION SYSTEM DETAILS (2 OF 2)
C-04	0	JUNE 2017	LANDFILL GAS FLARE COMPOUND LAYOUT
M-01	0	JUNE 2017	LANDFILL GAS COLLECTION SYSTEM CONDENSATE TRAP DETAILS



SOURCE:

EXISTING TOPOGRAPHICAL SURVEY COMPLETED OCTOBER 20, 2016 BY MCELHANNEY LAND SURVEYED LTD.

GROUNDWATER WELL LOCATION, DECOMMISSIONED WELL LOCATION, APPROXIMATE DOMESTIC GROUNDWATER WELL LOCATION, APPROXIMATE SURFACE WATER SAMPLE LOCATION FROM 2015 OPERATIONS AND MONITORING REPORT BY GHD.

APPROXIMATE LIMIT OF WASTE PER MCELHANNEY CONSULTING SERVICES LTD., DRAWING LIMIT OF EXISTING WASTE, DATED MAY 30, 2013.

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DRAFT CONCEPTUAL DESIGN

Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
LANDFILL GAS MANAGEMENT FACILITIES DESIGN PLAN

No.	Issue	Drawn	Approved	Date
1	DRAFT CONCEPTUAL DESIGN	KR	DL	05/01/2017

Drawn	K. RENNER	Designer	D. LIDDY
Drafting Check	K. DHALIWAL	Design Check	D. BARTON
Project Manager	G. FERRARO	Date	Jun 13, 2017
This document shall not be used for construction unless signed and sealed for construction.		Scale	1:1000
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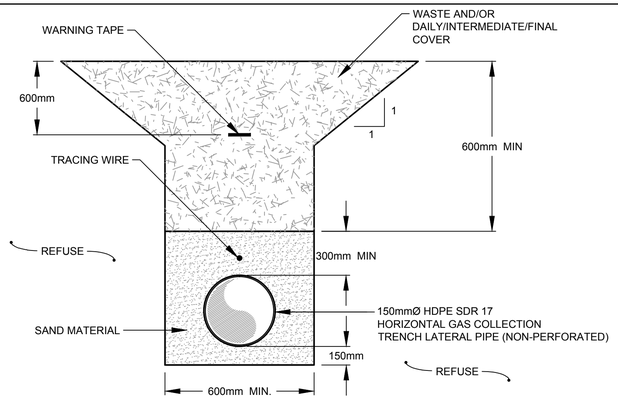
Project No. **56484-200**

Title
COLLECTION SYSTEM LAYOUT

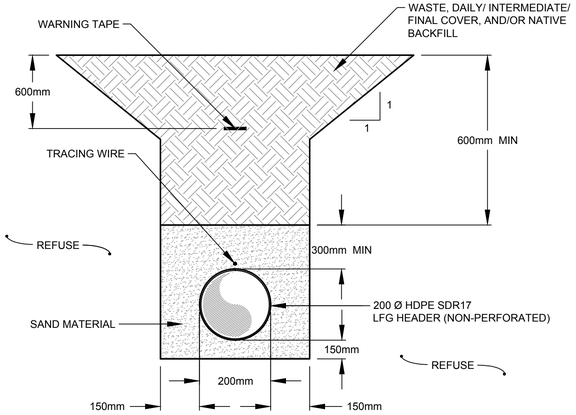
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C-01

Sheet 1 of 5

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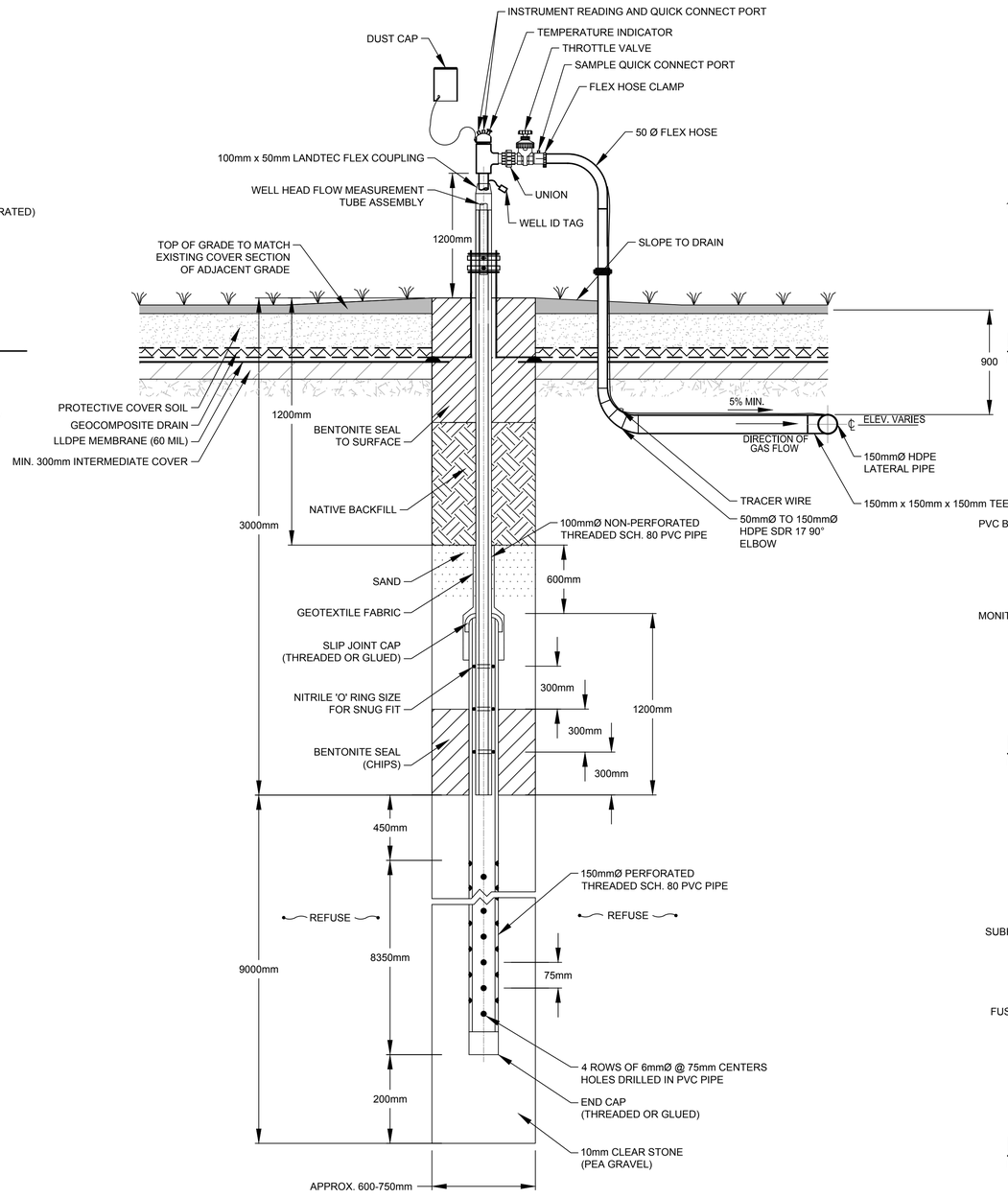
DETAIL 1 C-01 LFG LATERAL TRENCH
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DETAIL 2 C-01 LFG HEADER TRENCH
NTS

NOTE:

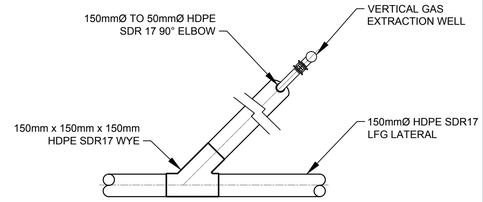
WITHIN THE LIMITS OF THE LANDFILL, NATIVE MATERIAL IS EXPECTED TO BE THE LANDFILL CLAY COVER, ALTHOUGH WASTE MAY BE ENCOUNTERED NEAR THE BOTTOM DEPTH OF THE TRENCH; THE BACKFILL MATERIAL FOR THE TRENCH WITHIN THE LANDFILL LIMITS IS EXPECTED TO BE THE EXISTING CLAY COVER. BEYOND THE LIMITS OF THE LANDFILL, THE NATIVE MATERIAL IS EXPECTED TO BE SAND, GRAVEL, AND/OR PEAT.



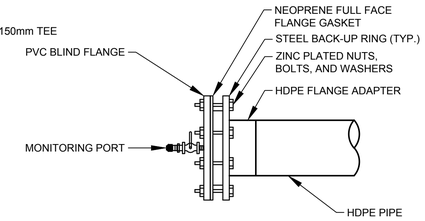
NOTE:

1. TYPICAL BORING DEPTH IS 15m OF REFUSE DEPTH.
2. EXTRACTION WELL LOCATIONS AND ELEVATIONS TO BE VERIFIED IN THE FIELD. THE OWNER AND ENGINEER MUST APPROVAL ALL CHANGES TO THE WELL SCHEDULE.
3. LIMESTONE, CRUSHED CONCRETE AND LIKE MATERIALS ARE NOT APPROVED AS BACKFILL MATERIAL.
4. BENTONITE TO BE HYDRATED DURING INSTALLATION OF WELL.

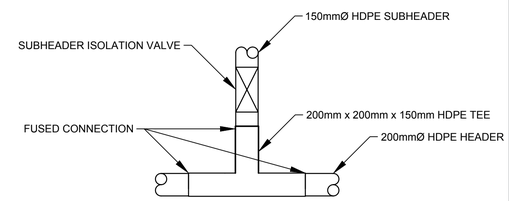
DETAIL 3 C-01 TYPICAL LFG EXTRACTION WELL AND WELL HEAD ASSEMBLY (TYP.)
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DETAIL 4 C-01 LATERAL WYE CONNECTION(TYP.)
NTS



DETAIL 5 C-03 BLIND FLANGE
NTS



DETAIL 6 C-01 TYPICAL "T" CONNECTION TO LFG HEADER
NTS

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DRAFT CONCEPTUAL DESIGN

Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
LANDFILL GAS MANAGEMENT FACILITIES DESIGN PLAN

No.	Issue	Drawn	Approved	Date
1	DRAFT CONCEPTUAL DESIGN	KR	DL	05/01/2017

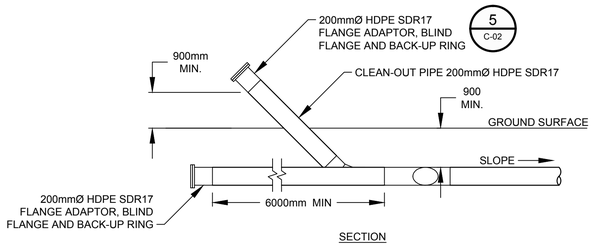
Drawn	K. RENNER	Designer	D. LIDDY
Drafting Check	K. DHALIWAL	Design Check	D. BARTON
Project Manager	G. FERRARO	Date	Jun 13, 2017
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Project No. **56484-200**

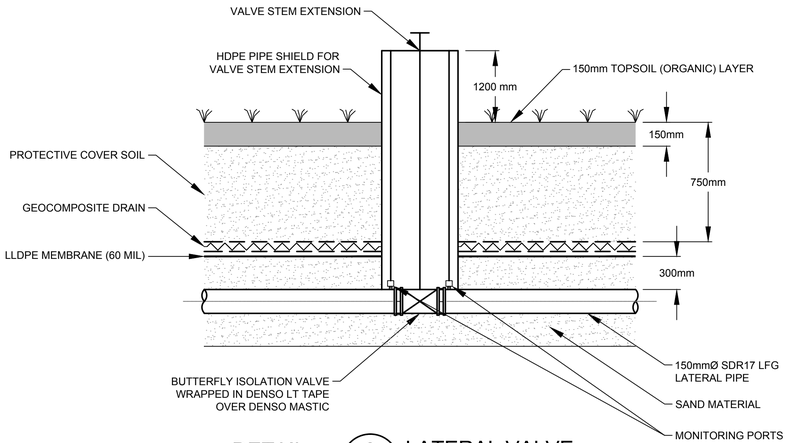
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Sheet No.
C-02

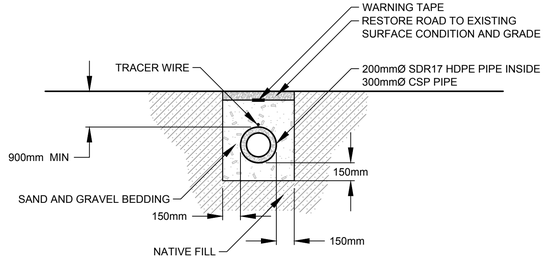
Sheet 2 of 5



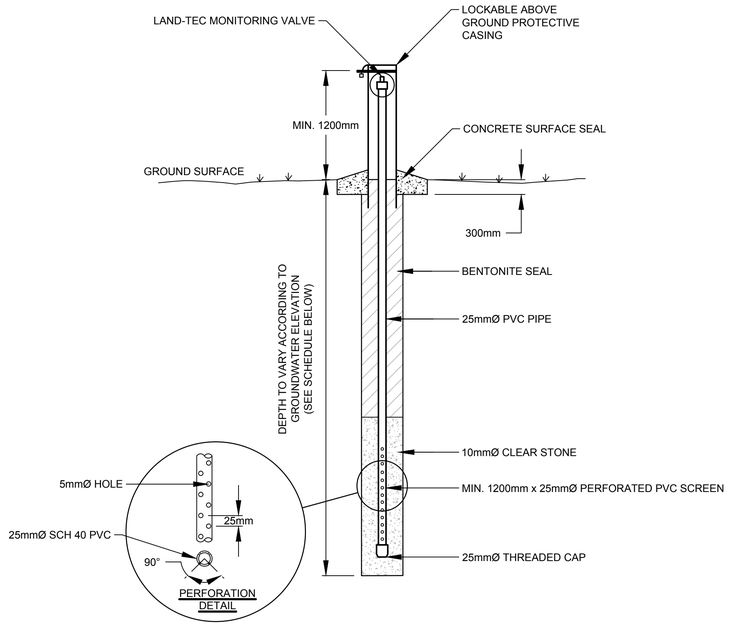
DETAIL 7 C-01 — LFG HEADER PIPE CLEANOUT (TYPICAL)
NTS



DETAIL 8 C-01 — LATERAL VALVE
NTS



DETAIL 9 C-01 — LFG PIPE TRENCH ROAD CROSSING
NTS



DETAIL 10 — LFG PROBE
NTS

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DRAFT
CONCEPTUAL DESIGN

Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
LANDFILL GAS MANAGEMENT FACILITIES DESIGN PLAN

No.	Issue	Drawn	Approved	Date
1	DRAFT CONCEPTUAL DESIGN	KR	DL	05/01/2017

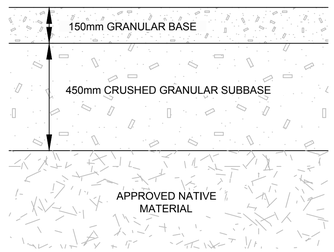
Drawn	K. RENNER	Designer	D. LIDDY
Drafting Check	K. DHALIWAL	Design Check	D. BARTON
Project Manager	G. FERRARO	Date	Jun 13, 2017
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Project No. **56484-200**

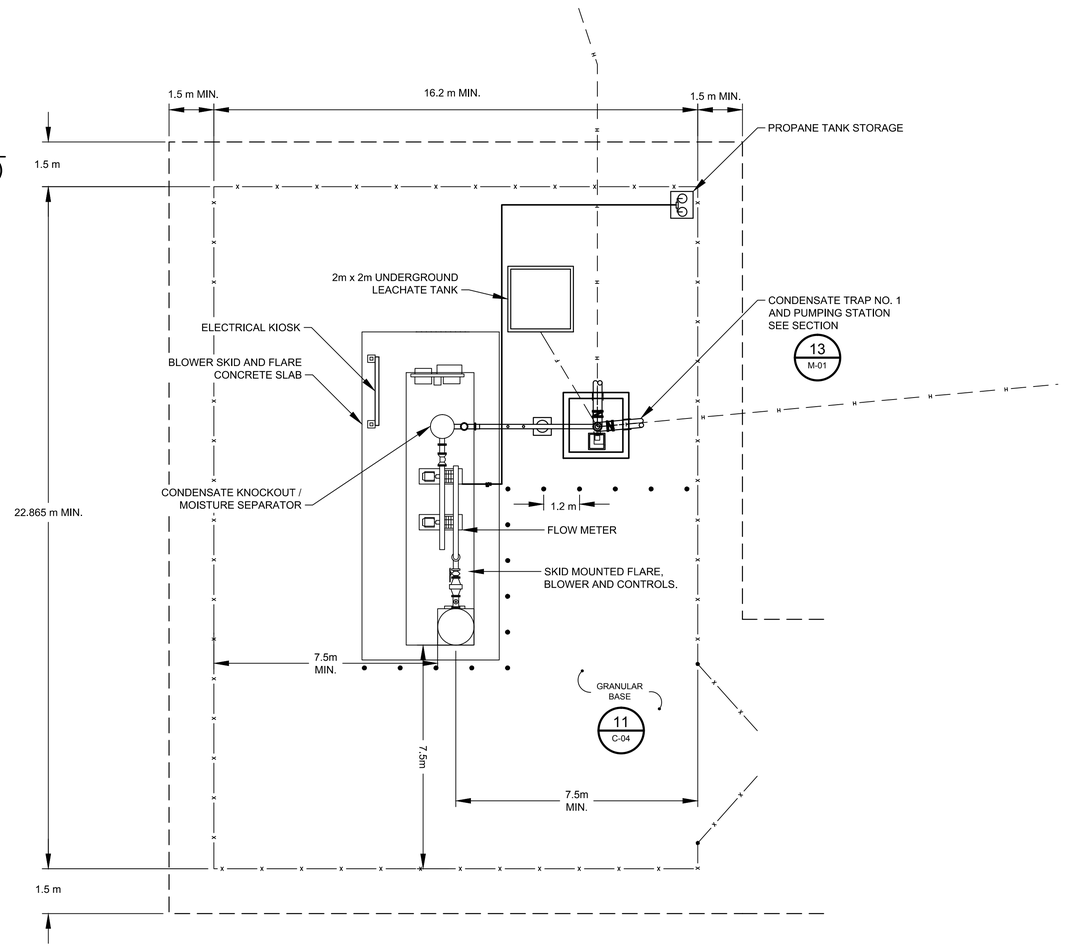
Title
LFG COLLECTION SYSTEM DETAILS (2 OF 2)

Sheet No.
C-03

Sheet 3 of 5



DETAIL 11 C-04 — COMPOUND GRANULAR BASE SECTION (TYPICAL)
NTS



DETAIL 12 C-01 — FLARE SYSTEM COUMPOUND
1:100

LEGEND

- CONDENSATE DRAIN
- LFG HEADER
- FENCE
- COMPOUND LIMIT

N

0 1 2 3m

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Project Manager	G. FERRARO	Date	Jun 13, 2017
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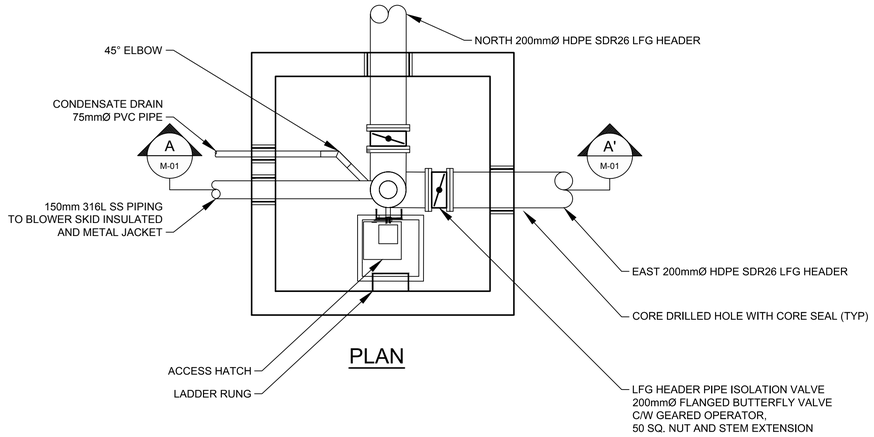
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Project No. **56484-200**

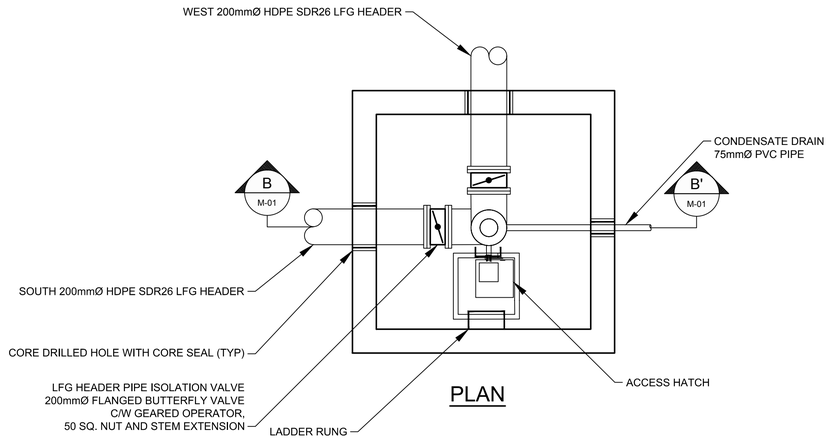
Title
LANDFILL GAS FLARE SYSTEM COMPOUND LAYOUT

Sheet No.
C-04

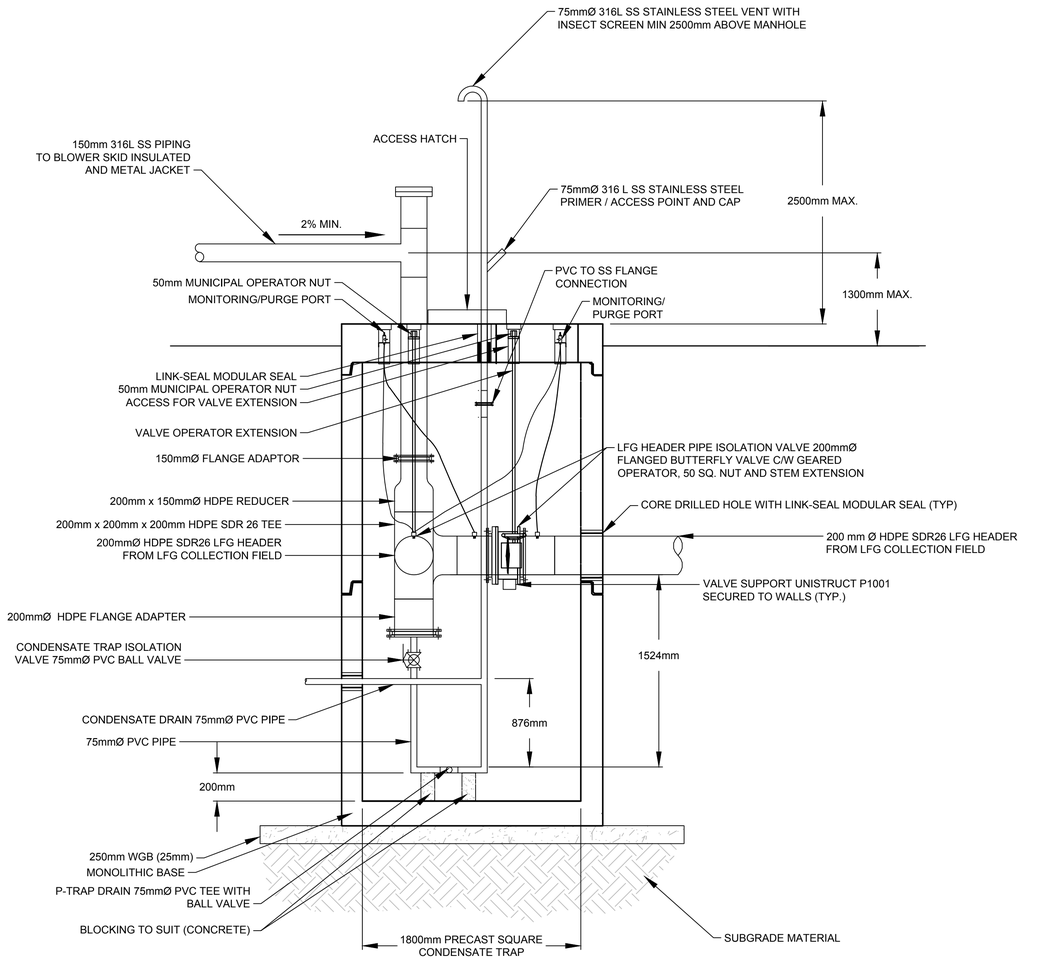
Sheet 4 of 5



PLAN



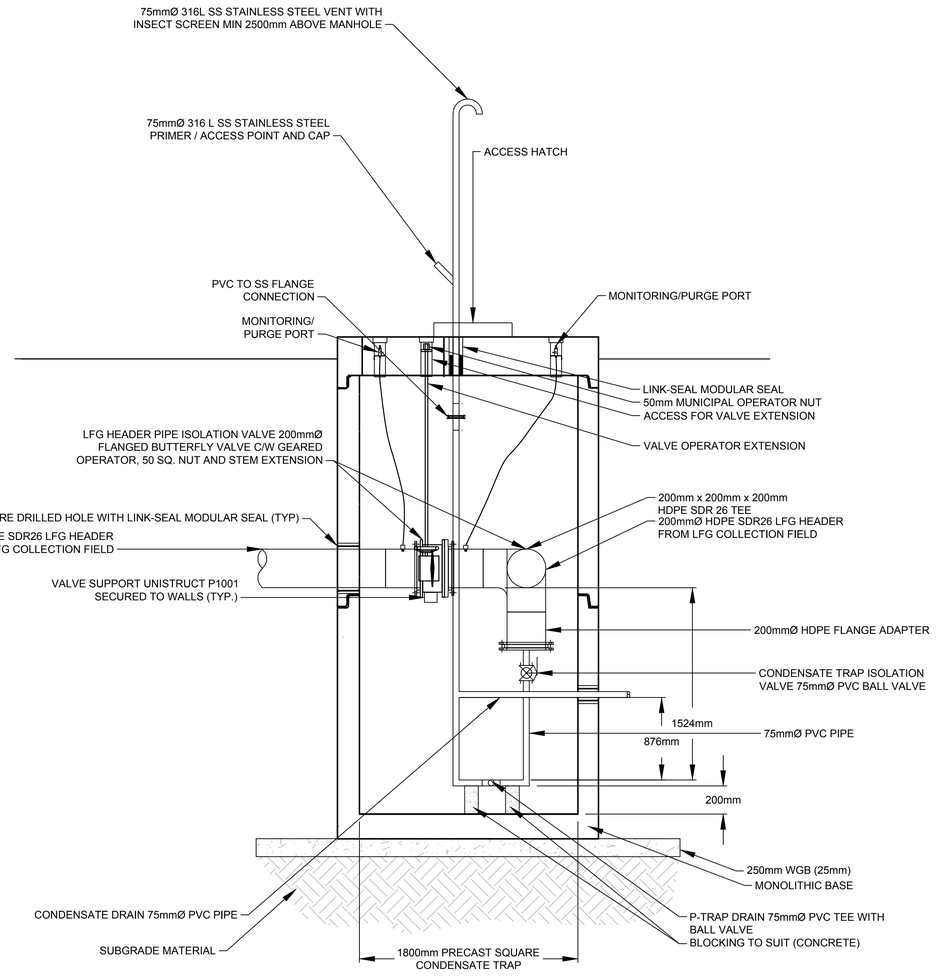
PLAN



SECTION A-A'

DETAIL 13 C-01 CONDENSATE TRAP No.1

NTS



SECTION B-B'

DETAIL 14 C-01 CONDENSATE TRAP No.2

NTS

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Client
CAMPBELL RIVER WASTE MANAGEMENT CENTRE

Project
LANDFILL GAS MANAGEMENT FACILITIES DESIGN PLAN

No.	Issue	Drawn	Approved	Date
1	DRAFT CONCEPTUAL DESIGN	KR	DL	05/01/2017

Drawn	K. RENNER	Designer	D. LIDDY
Drafting Check	K. DHALIWAL	Design Check	D. BARTON
Project Manager	G. FERRARO	Date	May 1, 2017
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Project No. **56484-200**

Title
LANDFILL GAS COLLECTION SYSTEM CONDENSATE TRAP DETAILS

Sheet No.
M-01

Sheet 5 of 5

Plot Date: 13 June 2017 - 4:24 PM Plotted By: Michael Donovan CAD File: P:\drawings\56000s\56484\56484-reports\56484-200(031)\56484-200(031)ME\56484-200(031)ME-WA001.dwg

Appendices

Appendix A
Updated LFG Generation Assessment

Appendix A

Updated LFG Generation Assessment
Updated Landfill Gas Management Facilities Design Plan
Campbell River Waste Management Centre
Comox Valley Regional District

	Relatively Inert	Moderately Decomposable	Decomposable	
Gas Production potential, Lo =	20	120	160	m^3 CH_4/tonne
Waste Composition (2006 SWMP)	36.1%	21.8%	42.2%	
lag time before start of gas production, lag =	1	years		
Historical Data Used (years)	30			
1st Year of Historical Data Used	1979			
4 Years after reporting year	2014			
methane (by volume)	50%			
carbon dioxide (by volume)	50%			
methane (density)	0.6557	kg/m^3	(25°C,1ATM)	
carbon dioxide (density)	1.7988	kg/m^3	(25°C,1ATM)	

Year	Annual Tonnage (tonnes)	Cumulative Waste-in-place (tonnes)	Waste Tonnage Relatively Inert (tonnes)	Waste Tonnage Moderately Decomposable (tonnes)	Waste Tonnage Decomposable (tonnes)	Methane Generation Rate, k Relatively Inert ($year^{-1}$)	Methane Generation Rate, k Moderately Decomposable ($year^{-1}$)	Methane Generation Rate, k Decomposable ($year^{-1}$)	Annual Methane Production (tonnes/yr)	Landfill Gas Production (m^3/hr)	Greenhouse Gas Emissions (as CO_2e/year)
1980	10,334	10,334	3,725	2,250	4,356	0.02	0.06	0.11	59.2	20.6	1,243
1981	10,545	20,879	3,802	2,296	4,445	0.02	0.06	0.11	114.0	39.7	2,393
1982	10,760	31,639	3,879	2,343	4,535	0.02	0.06	0.11	164.8	57.4	3,461
1983	10,980	42,619	3,958	2,391	4,628	0.02	0.06	0.11	212.1	73.9	4,454
1984	11,204	53,823	4,039	2,440	4,723	0.02	0.06	0.11	256.3	89.2	5,382
1985	11,432	65,255	4,121	2,489	4,819	0.02	0.06	0.11	297.7	103.6	6,251
1986	11,666	76,921	4,206	2,540	4,917	0.02	0.06	0.11	336.6	117.2	7,068
1987	11,904	88,825	4,291	2,592	5,018	0.02	0.06	0.11	373.2	130.0	7,838
1988	12,147	100,972	4,379	2,645	5,120	0.02	0.06	0.11	407.9	142.0	8,567
1989	12,395	113,367	4,468	2,699	5,225	0.02	0.06	0.11	440.9	153.5	9,259
1990	12,648	126,015	4,560	2,754	5,331	0.02	0.06	0.11	472.3	164.4	9,918
1991	12,906	138,921	4,653	2,810	5,440	0.02	0.06	0.11	502.3	174.9	10,549
1992	13,169	152,090	4,747	2,868	5,551	0.02	0.06	0.11	531.2	184.9	11,154
1993	13,438	165,528	4,844	2,926	5,664	0.02	0.06	0.11	558.9	194.6	11,738
1994	13,712	179,240	4,943	2,986	5,780	0.02	0.06	0.11	585.8	204.0	12,302
1995	13,992	193,232	5,044	3,047	5,898	0.02	0.06	0.11	611.9	213.0	12,849
1996	14,278	207,510	5,147	3,109	6,018	0.02	0.06	0.11	637.3	221.9	13,382
1997	14,569	222,079	5,252	3,172	6,141	0.02	0.06	0.11	662.1	230.5	13,903
1998	14,867	236,946	5,360	3,237	6,267	0.02	0.06	0.11	686.4	239.0	14,414
1999	15,170	252,116	5,469	3,303	6,394	0.02	0.06	0.11	710.3	247.3	14,916
2000	22,042	274,158	7,946	4,800	9,291	0.02	0.06	0.11	771.4	268.6	16,199
2001	21,642	295,799	7,802	4,713	9,122	0.02	0.06	0.11	824.6	287.1	17,317
2002	22,009	317,808	7,934	4,792	9,277	0.02	0.06	0.11	875.1	304.7	18,376
2003	23,638	341,446	8,522	5,147	9,964	0.02	0.06	0.11	930.2	323.9	19,535
2004	26,242	367,689	9,460	5,714	11,061	0.02	0.06	0.11	995.3	346.6	20,901
2005	26,700	394,389	9,626	5,814	11,254	0.02	0.06	0.11	1057.0	368.0	22,198
2006	28,295	422,684	10,200	6,161	11,926	0.02	0.06	0.11	1122.3	390.8	23,567
2007	31,207	453,891	11,250	6,795	13,154	0.02	0.06	0.11	1198.2	417.2	25,163
2008	30,096	483,987	10,850	6,554	12,686	0.02	0.06	0.11	1260.9	439.0	26,478
2009	26,405	510,392	9,519	5,750	11,130	0.02	0.06	0.11	1296.7	451.5	27,231
2010	27,358	537,750	9,863	5,957	11,532	0.02	0.06	0.11	1334.9	464.8	28,032
2011	26,130	563,880	9,420	5,690	11,014	0.02	0.06	0.11	1362.7	474.5	28,616
2012	25,698	589,578	9,264	5,596	10,832	0.02	0.06	0.11	1385.6	482.5	29,098
2013	26,992	616,570	9,731	5,878	11,377	0.02	0.06	0.11	1414.1	492.4	29,696
2014	28,373	644,943	10,229	6,178	11,959	0.02	0.06	0.11	1448.0	504.2	30,409
2015	25,303	670,246	9,122	5,510	10,665	0.02	0.06	0.11	1461.5	508.9	30,691
2016	25,490	695,736	9,189	5,551	10,744	0.02	0.06	0.11	1474.9	513.6	30,974
2017	26,371	722,107	9,507	5,742	11,116	0.02	0.06	0.11	1492.4	519.6	31,341
2018	26,506	748,613	9,555	5,772	11,172	0.02	0.06	0.11	1509.3	525.5	31,695
2019	26,409	775,022	9,520	5,751	11,131	0.02	0.06	0.11	1524.2	530.7	32,009
2020	26,016	801,038	9,379	5,665	10,966	0.02	0.06	0.11	1535.7	534.7	32,250
2021	26,158	827,196	9,430	5,696	11,026	0.02	0.06	0.11	1547.2	538.7	32,491

Sources:

- Landfill Gas Generation Assessment Procedure Guidance Report, Conestoga-Rovers & Associates, March 2009
- Landfill tonnages:
  - -1965-1999 CH2MHill LFG Management Plan (Based on assumption that the population increased at a 2% annual rate between 1965 and 1998, and that the waste volume increase was directly proportional to the population rate)
  - -2000-2016 Supplied by CVRD

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Appendix H
Contaminating Lifespan Assessment Calculations

Alkalinity (1st Order)

Background Groundwater Conditions
Maximum Anticipated Concentration

C_t	41.2	mg/L	
C_B	4,200	mg/L	"Worst case" concentration
λ	0.072	y^{-1}	
t	64.22	y	Time to reduce below Criteria
t	65	y	Time, rounded up
C_o	38.97	mg/L	Check at t (rounded up)

Note: This calculation uses the highest concentration found in leachate at similar landfills with the same waste stream

Note: Background groundwater conditions characterized using groundwater quality data from upgradient monitoring wells AM02-01 and MW01-16

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

Alkalinity (1st Order)

Background Groundwater Conditions
Mean Anticipated Concentration

C_t	41.2	mg/L	
C_B	1,314	mg/L	Mean concentration
λ	0.072	y^{-1}	
t	48.08	y	Time to reduce below Criteria
t	49	y	Time, rounded up
C_o	38.58	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration found in leachate at similar landfills with the same waste stream

Note: Background groundwater conditions characterized using groundwater quality data from upgradient monitoring wells AM02-01 and MW01-16

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

Ammonia (1st Order)
British Columbia CSR

Drinking Water Standards
Maximum Anticipated Concentration

C_t	1.31	mg/L	
C_B	880	mg/L	"Worst case" concentration
λ	0.1	y^{-1}	
t	65.10	y	Time to reduce below Criteria
t	66	y	Time, rounded up
C_o	1.20	mg/L	Check at t (rounded up)

Note: This calculation uses the highest concentration found in leachate at similar landfills with the same waste stream

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

Ammonia (1st Order)
British Columbia CSR

Drinking Water Standards
Mean Anticipated Concentration

C_t	1.31	mg/L	
C_B	189	mg/L	Mean concentration
λ	0.1	y^{-1}	
t	49.72	y	Time to reduce below Criteria
t	50	y	Time, rounded up
C_o	1.27	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration found in leachate at similar landfills with the same waste stream

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

Chloride (1st Order)
British Columbia CSR

Drinking Water Standards
Maximum Anticipated Concentration

C_t	250	mg/L	
C_B	3,700	mg/L	"Worst case" concentration
λ	0.065	y^{-1}	
t	41.46	y	Time to reduce below Criteria
t	42	y	Time, rounded up
C_o	241.31	mg/L	Check at t (rounded up)

Note: This calculation uses the highest concentration found in leachate at similar landfills with the same waste stream

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

Chloride (1st Order)
British Columbia CSR

Drinking Water Standards
Mean Anticipated Concentration

C_t	250	mg/L	
C_B	432	mg/L	Mean concentration
λ	0.065	y^{-1}	
t	8.41	y	Time to reduce below Criteria
t	9	y	Time, rounded up
C_o	240.67	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration found in leachate at similar landfills with the same waste stream

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 I
Current Monitoring Specifications

Table 1

Water Quality Monitoring Program Summary
Environmental Monitoring Program Services - 2017 Term
Campbell River Waste Management Centre
Comox Strathcona Waste Management

Sampling Location	*Sampling Location Purpose*	*Sample Matrix*	*Hydraulic Monitoring*	*February*	*May*	*August*	*November*
Groundwater Monitoring Program (21 locations)							
AG99-01	Monitor downgradient groundwater quality to the east of the Site. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
AG99-02	Monitor downgradient groundwater quality to the east of the Site. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
AG99-04	Monitor downgradient groundwater quality to the east of the Site. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
AG99-05	Monitor downgradient groundwater quality to the east of the Site. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
AG99-06	Downgradient of the Site to the northeast. Off-site	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
MW01-16	Background location	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
AM02-01	Background location	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
EBA04-1	Tap from building	WG		Schedule A	Schedule A	Schedule A	Schedule A
EBA04-3	Downgradient of the Site to the northeast. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
EBA04-4	Northeast area of the landfill	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
EBA04-6	Northeast toe of landfill. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
EBA04-7	Northeast toe of landfill. Off-site	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
EBA11-1	Downgradient of the Site to the northeast. Off-site	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
EBA11-2	Downgradient of the Site to the northeast. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A

Table 1

Water Quality Monitoring Program Summary
Environmental Monitoring Program Services - 2017 Term
Campbell River Waste Management Centre
Comox Strathcona Waste Management

Sampling Location	*Sampling Location Purpose*	*Sample Matrix*	*Hydraulic Monitoring*	*February*	*May*	*August*	*November*
EBA11-3	Downgradient of the Site to the northeast. Off-site	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
EBA11-4	Downgradient of the Site to the northeast. Off-site	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
GLL93-4	Northeast toe of landfill. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
HBT94-1	Southeast property line	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
HBT94-2	Southeast property line	WG	√	Schedule A Schedule B	Schedule A	Schedule A Schedule B	Schedule A
HBT94-3	Southeast property line	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
HBT94-5	Monitor downgradient groundwater quality to the east of the Site. Off-site	WG	√	Schedule A	Schedule A	Schedule A	Schedule A
Surface Water Monitoring Program (3 locations)							
SW-1	Cold Creek Tributary	WS	√	Schedule A	Schedule A	Schedule A	Schedule A
SW-2	Cold Creek Slough	WS	√	Schedule A	Schedule A	Schedule A	Schedule A
SW03-17	Unnamed Pond Upstreatm of SW-1	WS	√	Schedule A	Schedule A	Schedule A	Schedule A
Field Quality Assurance/Quality Control							
Field Blank		WG		Schedule A	Schedule A	Schedule A	Schedule A
Groundwater Duplicate		WG		2x Schedule A Schedule B	2x Schedule A	2x Schedule A Schedule B	2x Schedule A
Surface Water Duplicate		WS		Schedule A			
Trip Blank		WG		Schedule B	Schedule B	Schedule B	Schedule B
Extra Bottles							
		WG		Schedule A Schedule B	Schedule A Schedule B	Schedule A Schedule B	Schedule A Schedule B
		WS		Schedule A	Schedule A	Schedule A	Schedule A

Notes:

WG - Groundwater
WS- Surface Water
√ - Every monitoring event
EBA04-1, cannot measure water level

Table 2

Monitoring Parameter Schedules
Environmental Monitoring Program Services - 2017 Term
Campbell River Waste Management Centre
Comox Strathcona Waste Management

	Groundwater	*Surface Water*
Schedule A		
Hydraulic Monitoring		
Water Level and Depth to Bottom	√	
Flow		√
Field Parameters		
Specific Conductance, Field	√	√
Dissolved Oxygen, Field	√	√
pH, Field	√	√
Temperature, Field	√	√
ORP	√	√
General Chemistry		
Alkalinity (speciated)	√	√
Chloride	√	√
Fluoride	√	√
pH	√	√
Specific Conductance	√	√
Sulphate (Dissolved)	√	√
Nitrate (as N)	√	√
Nitrite (as N)	√	√
Metals (including Mercury, Sulphur, and Hardness)		
Dissolved	√	√
Total		√
Aluminum	√	√
Antimony	√	√
Arsenic	√	√
Barium	√	√
Beryllium	√	√
Bismuth	√	√
Boron	√	√
Cadmium	√	√
Calcium	√	√
Chromium	√	√
Cobalt	√	√
Copper	√	√
Iron	√	√
Lead	√	√
Lithium	√	√
Magnesium	√	√
Manganese	√	√
Mercury	√	√
Molybdenum	√	√
Nickel	√	√
Phosphorus	√	√
Potassium	√	√
Selenium	√	√
Silicon	√	√
Silver	√	√
Sodium	√	√
Strontium	√	√
Sulphur	√	√
Thallium	√	√
Tin	√	√
Titanium	√	√
Uranium	√	√
Vanadium	√	√
Zinc	√	√
Zirconium	√	√

Table 2

Monitoring Parameter Schedules
Environmental Monitoring Program Services - 2017 Term
Campbell River Waste Management Centre
Comox Strathcona Waste Management

	Groundwater	*Surface Water*
Schedule B		
Volatile Organic Compounds (VOCs)		
1,1,1,2-tetrachloroethane	√	
1,1,1-trichloroethane	√	
1,1,2,2-tetrachloroethane	√	
1,1,2-trichloroethane	√	
1,1-dichloroethane	√	
1,1-dichloroethene	√	
1,2-dichlorobenzene	√	
1,2-dichloroethane	√	
1,2-dichloropropane	√	
1,3-dichlorobenzene	√	
1,4-dichlorobenzene	√	
Benzene mg/L	√	
Bromodichloromethane	√	
Bromoform	√	
Bromomethane	√	
Carbon tetrachloride	√	
Chlorobenzene	√	
Chlorodibromomethane	√	
Chloroethane	√	
Chloroform	√	
Chloromethane	√	
cis-1,2-dichloroethene	√	
cis-1,3-dichloropropene	√	
Dibromomethane	√	
Dichloromethane	√	
Ethylbenzene	√	
m & p-Xylene		
Methyl-tert-butylether (MTBE)	√	
o-Xylene	√	
Styrene	√	
Tetrachloroethene	√	
Toluene	√	
trans-1,2-dichloroethene	√	
trans-1,3-dichloropropene	√	
Trichlorofluoromethane	√	
Vinyl chloride	√	
Xylenes (Total)	√	
Petroleum Hydrocarbons		
Total Petroleum Hydrocarbons VH (C6-C10)	√	
Total Petroleum Hydrocarbons VPH (C6-C10)LessBTEX	√	

Appendix J
Fire Safety and Emergency Contingency Plan

FIRE SAFETY AND EMERGENCY CONTINGENCY PLAN

CAMPBELL RIVER WASTE MANAGEMENT CENTRE
CAMPBELL RIVER, BRITISH COLUMBIA

Prepared For: **Campbell River Waste Management Centre.**
6700 Argonaut Road
Campbell River, British Columbia

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MARCH 3, 2017
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REVISIONS

DATE	REVISION NO.	AUTHOR/COMPANY	

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1.0 INTRODUCTION

The operators of the Campbell River Waste Management Centre (CRWMC), 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 Site is located within the city limits of Campbell River, BC at 6700 Argonaut Road approximately 7.5 kilometres (km) east of the city centre. The Site is composed of two land parcels, Blocks C and J within District Lot 85 of the Sayward Land District. The total Site area is 29.7 hectares (ha). The CRWMC is owned by the Comox Valley Regional District (CVRD) and operated by Barry and Vale Contracting Ltd.

The CRWMC currently operates under operational certificate (OC) MR-02401. The Landfill receives industrial, commercial and institutional (ICI) waste, municipal solid waste (MSW), construction and demolition (C&D) wastes, yard waste, carcasses, clean fill, clean wood waste, drywall/gypsum waste, cut grass & raked leaves. The Site also receives the following wastes which are stockpiled and periodically removed for off-Site disposal: Cardboard and mixed paper Recycling plastic containers (1-7), tires, propane Tanks, household and automotive batteries, appliances, scrap metal, used oil and electrical items and household hazardous wastes (HHW).

The following sections detail the Fire Safety and Emergency Contingency Plan for waste disposal operations at CRWMC. 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 weather. The following sections outline the general procedures for dealing with emergency situations that may potentially be experienced at the Site.

This Plan will be reviewed by all on-Site personnel and kept at CRWMC. 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.

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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 west on Argonaut Road
- Turn right onto Gold River Hwy/BC-28 E toward Campbell river
- 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
MOE 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	1-800-663-5555 *5555 Cellular

Barry and Vale Contracting Ltd. (CRWMC Operator)

- Moe Vale 250-287-6387 (Cell)
- Mathew Peterson 250-203-2134 (Cell)

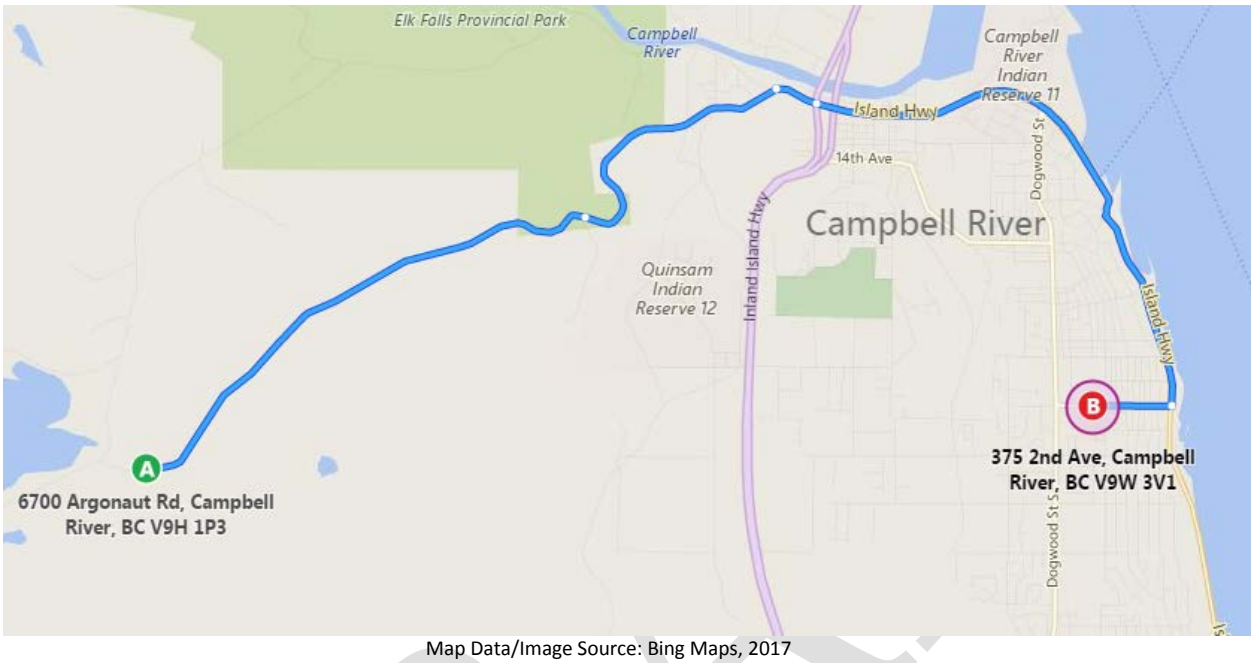
Comox Valley Regional District (CRWMC Owner)

- Jesse Lee 250-344-6475 (Cell)
- James Mathers 250-218-8318 (Cell)

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FIGURE 2.1
EMERGENCY HOSPITAL ROUTE

TO BE POSTED IN CONSPICUOUS AREAS OF THE WORKPLACE



Map Data/Image Source: Bing Maps, 2017

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 west on Argonaut Road
- Turn right onto Gold River Hwy/BC-28 E toward Campbell river
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- 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

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3.0 EMERGENCY EQUIPMENT AVAILABLE ON SITE

The following emergency equipment is available at the scale building and maintenance shop:

- First aid kit (Level 1 Kit) – Scale building
- 20 pound Class A, B, and C dry chemical fire extinguisher – Transfer station building
- Petroleum spill containment kit
- Air horn
- Telephone – Scale building

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 and spill kits.

A suitable pump with appropriate length of hose will be kept available on-site at all time to pump water for emergency use.

The facility is equipped with a well for emergency use which may be accessed by three stand pipes at the site. Two 2,000 gallon water tanks are kept on site at all times. The tanks are equipped with fire pumps and may be transported via roll-off truck.

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4.0 EMERGENCY ROUTES AND ASSEMBLY POINTS

The CRWMC 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.

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5.0 MEDICAL EMERGENCIES

The CRWMC Operator will employ, and assign to the Site, a competent and authorized representative, herein referred to as the HSO (Health and Safety Officer). A Site Health & Safety Representative will also be selected. The Site Supervisor will be present at the CRWMC during normal operating hours.

The CRWMC 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 CRWMC 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 CRWMC 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 CRWMC (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

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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.

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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. The Landfill Site should have year-round and immediate access to a water supply capable of a sustained flow of water for firefighting purposes that exceeds 4,000 liters per minute or suitable alternative fire equipment.

LANDFILL FIRES

The risk of landfill fires can be reduced through the implementation of appropriate landfill operational practices including the following:

- Placement of daily/intermediate cover material.
- Adequate stockpiling of soil material for daily/intermediate cover and fire control.
- Availability and maintenance of appropriate equipment for fire control.
- Prohibition of smoking and unpermitted hot work on and around the Landfill.

Should a landfill fire occur, the nature of the fire should determine the response. A surface fire should be extinguished by isolating the load on fire and smothering the fire with cover soil. A fire within the landfill should be extinguished through a combination of cover soil and potentially water suppression. Excavating waste in the vicinity of a landfill fire may allow oxygen intrusion into the waste further feeding the fire and should not occur outside of an approved fire response plan.

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

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- 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

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7.0 SPILLS OR LEAKS

The CRWMC 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 CRWMC 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 CRWMC 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 Provincial Emergency Program (PEP) and the B.C. Ministry of Environment 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. 263/90) (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

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- 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.

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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 CRWMC 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 CRWMC 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 CRWMC 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 CRWMC Operator will undertake advanced planning for site preparation/access, snow removal, and the stockpiling and storage of waste cover material.

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The following procedures will be taken during winter weather conditions:

- The CRWMC 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 CRWMC 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

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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

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10.0 HAZARDOUS SUBSTANCE INVENTORY & NOTIFICATION OF FIRE DEPARTMENT

The CRWMC 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 (MSDS) for the material.

As part of Site operations, the CRWMC Operator performs visual inspections of all waste loads received at the Site and any material not authorized for discharge or temporary storage at Site pending off-Site disposal at the Site 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 CRWMC and materials stored on-Site pending removal for off-Site disposal (e.g. HHW) 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.

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Reportable Limits for Spills and Releases
Campbell River Fire and Emergency Contingency Plan
Campbell River Waste Management Centre
Comox Strathcona Waste Management

Substance spilled[(1)]	**Specified amount**[(1)]
Explosives Class 1 as defined in section 2.9 of the Federal Regulations	Any quantity that could pose a danger to public safety or 50 kg
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"
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 preceding items	25 kg or 25 L
A substance, not covered by ipreceding items, that can cause pollution	200 kg or 200 L
Natural gas	10 kg, if there is a breakage in a pipeline or fitting operated above 100 psi that results in a sudden and uncontrolled release of natural gas

NOTES:
(1) Substance definitions and reportable spill amounts from BC Spill Reporting Regulation (B.C. Reg. 263/90 including amendments upto B.C. Reg 376/2008, December 9,2008), current to May 2, 2017

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.

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