REPORT

Updated Landfill Monitoring Program

Westside Landfill

Submitted to:

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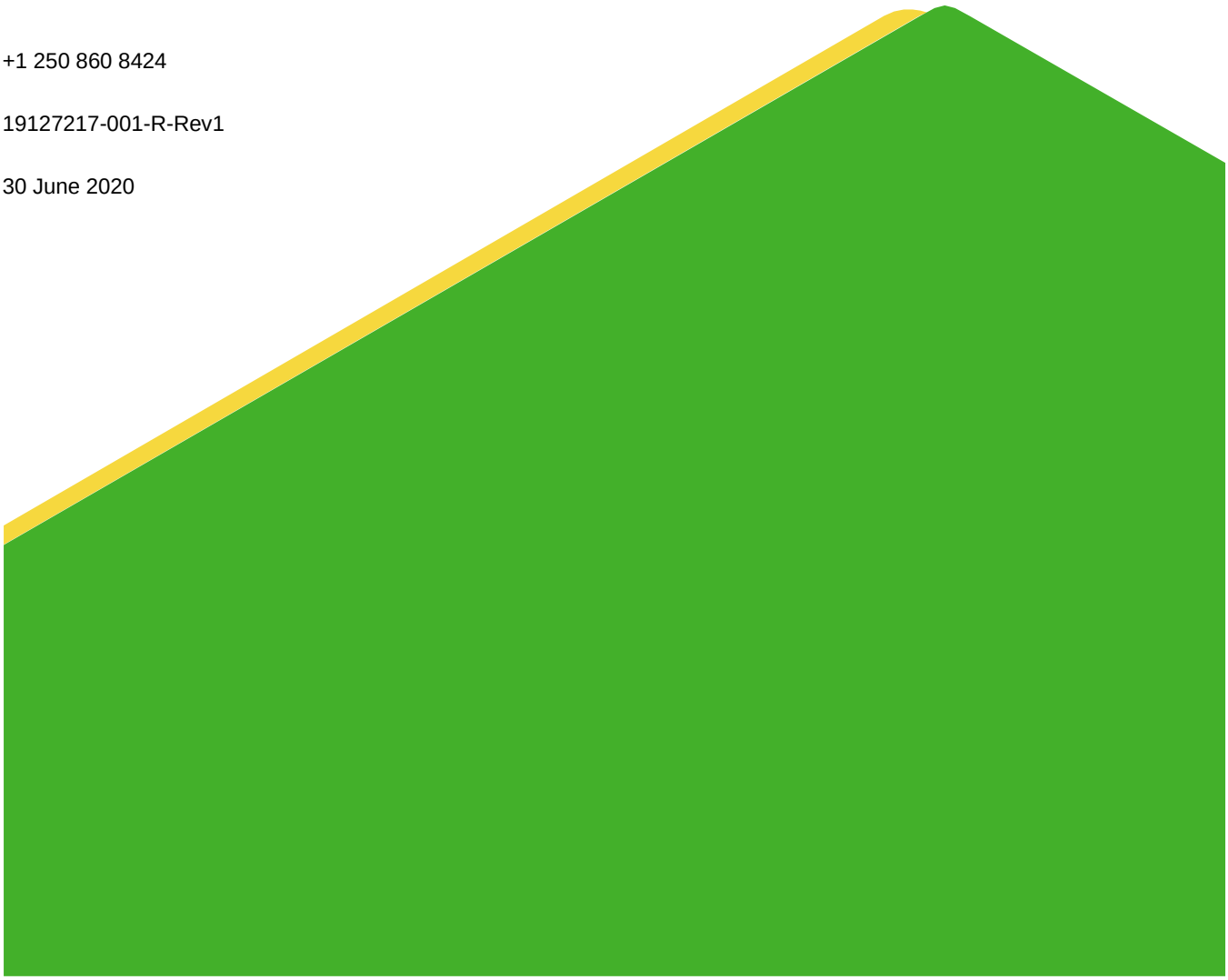

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APPENDIX B
Updated Landfill Monitoring Program (Golder 2014) and MoE Approval Letter dated 26 July 2016

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by the Regional District of Central Okanagan (RDCO) to update the Landfill Monitoring Program currently undertaken at the Westside Landfill (the Site), located in West Kelowna, BC (Figure 1). The objective of this work is to provide updates to the Landfill Monitoring Program for the Westside Landfill to reflect revisions to the landfill gas monitoring program and groundwater monitoring and sampling program. This report should be read in conjunction with the 2013 Landfill Gas Management Plan, 2014 Updated Landfill Monitoring Program, and 2015 Closure Plan prepared for the Site.

1.1 Background

Westside Landfill was operated as a municipal solid waste landfill under Operational Certificate (OC) PR#12217 (Appendix A) issued by British Columbia Ministry of Environment and Climate Change Strategy (ENV). Westside Landfill ceased receiving waste in 2010 and was partially covered. A Closure Plan was developed (Golder 2015) and was accepted by the ENV, as confirmed in a letter dated 6 September 2017 (Appendix A). The closure works, which included earthworks, drainage works and the placement of topsoil, were completed in 2018 under the supervision of Urban System Ltd. (USL); the USL construction drawings were provided in the 2018 Annual Report (Golder 2019). The Site closure works were finalized on 7 November 2018 with the completion of the seeding and fertilizing activities on the landfill footprint.

Monitoring of the Site was carried out as initially outlined in OC PR PR#12217, with modifications over the years. Golder prepared a Landfill Gas Management Plan (LGMP) (Golder 2013), which began being implemented in May of 2013. Based on assessment of the results of the landfill gas monitoring over 2013 and experience with implementing the LGMP, the Updated Landfill Monitoring Program (Golder 2014) recommended some modifications. The 2014 Updated Landfill Monitoring Program proposed some additional changes to other aspects of site monitoring, in part to reflect the fact that the Site no longer receives waste and was in the process of being closed. The proposed changes to both groundwater and landfill gas monitoring were approved by ENV in a letter dated 26 July 2016 (Appendix B). The approval letter states that these interim changes must be reviewed and revised upon landfill closure, if necessary. Recommendations for changes to the monitoring and inspection plan outlined in the 2015 Closure Plan were formally accepted by ENV as of September 2017 (Appendix A).

No changes in the monitoring and inspection plan were anticipated until sufficient post-closure monitoring has been conducted to determine if the closure works affected methane (or other potentially problematic landfill gases) adversely. However, three landfill gas monitoring wells[1] were installed since the 2014 Updated Landfill Monitoring Program. In addition, seven landfill gas monitoring wells[2] were required to be decommissioned in June 2018 due to development on the property located north of the Westside Landfill.

Therefore, an update to the LGMP is required to reflect the decommissioning of these 2007 landfill gas monitoring wells and an addition of the 2015 landfill gas monitoring wells.

[1] VP15-01, VP15-02, and VP15-03

[2] VP07-11, VP07-12, VP07-13, VP07-17, VP07-18, VP07-19, and VP07-20

2.0 PROPOSED REVISIONS TO LANDFILL MONITORING PROGRAM

The scope of work completed as part of this Updated Landfill Monitoring program included:

- Update the Landfill Monitoring Program to reflect the landfill gas monitoring wells installed since the 2014 Updated Landfill Monitoring Program was submitted.
- Update the Landfill Monitoring Program to reflect the landfill gas monitoring wells decommissioned in 2018 and provide recommendations for replacement of the decommissioned landfill gas monitoring wells, if required.
- Review the required monitoring and sampling requirements following closure activities of the Westside Landfill.

These proposed revisions are discussed in Sections 2.1 through to 2.4 of this report.

2.1 Addition of Three Landfill Gas Monitoring Wells

In 2015 (following the last update to the Landfill Monitoring Program), three additional landfill gas monitoring wells were installed on the Site, VP15-01, VP15-02, and VP15-03. These three gas monitoring wells were installed as a result of elevated methane concentrations measured at BH102. VP15-01 and VP15-02, were installed as step-out monitors to VP07-02, which has historically served as the step-out monitor for BH102. VP15-01 and VP15-02 were designed in part to monitor methane gas that might be partially by-passing VP07-02. VP15-03 was installed near BH102 at a greater depth to assess the potential for methane flow at greater depth. The locations of VP15-01, VP15-02, and VP15-03 relative to BH102 and VP07-02 are shown on Figure 2.

Since their installation in 2015, these locations (VP15-01, VP15-02, and VP15-03) have been monitored along with the existing locations (BH102 and VP07-02) and have been included in the partial monitoring events in June, July, September, and October[3]. It is recommended that VP15-01, VP15-02, and VP15-03 continue to be monitored monthly and included in the partial monitoring events.

2.2 Decommissioning of Seven Landfill Gas Monitoring Wells

Seven landfill gas monitoring wells (VP07-11, VP07-12, VP07-13, VP07-17, VP07-18, VP07-19, and VP07-20) were required to be decommissioned in June 2018 due to the development on the property located north of the Westside Landfill. These gas monitoring wells were part of the 2014 Updated Landfill Monitoring Program.

[3] Monthly monitoring is conducted at the gas monitoring wells across the Site except in June, July, September, and October, where only select gas monitoring locations are monitored as stated in the 2014 Updated Landfill Monitoring Program (Golder Associates Ltd. 2014).

2.3 Replacement of Landfill Gas Monitoring Wells Located North of the Westside Landfill

As outlined in Section 2.2, seven landfill gas monitoring wells were decommissioned in June 2018 due to the development on the property located north of the Westside Landfill. Methane levels at one of these former monitors, VP07-11, exceeded the action level criteria for methane as specified in the 2015 Closure Plan (Golder 2015) in February and March of 2018[4]. A summary of the historical monitoring results for VP07-11 is provided in Table 1.

Table 1: VP07-11 Historical Methane Exceedances

Date	Carbon Dioxide (%)	Oxygen (%)	Methane (ppm)	Methane (%LEL)	Carbon Monoxide (ppm)	Hydrogen Sulfide (ppm)
March 2013	1.6	18.4	9,300	**18.6%**	0	0
April 2013	1.3	17.5	15,250	**30.5%**	0	0
February 2014	1.2	18.7	9,900	**19.8%**	0	0
February 2017	1.1	16.5	5,500	**11.0%**	0	0
February 2018	1.3	16.5	12,250	**24.5%**	0	0
March 2018	1.5	14.7	23,500	**47.0%**	0	0

At VP07-11, methane levels generally exceeded the action level in the late winter / early spring when near surface soils are expected to be saturated or nearly saturated or when there is a greater potential of near surface ice and snow cover; all of which can reduce vertical venting of gas, thus promoting lateral migration of landfill gas.

The methane action levels at the other decommissioned monitors were not exceeded during the monitoring period 2011 to 2018 (as shown in Chart 1).

[4] The action level specified in the 2015 Closure Plan for methane is 10% LEL (lower explosive limit).

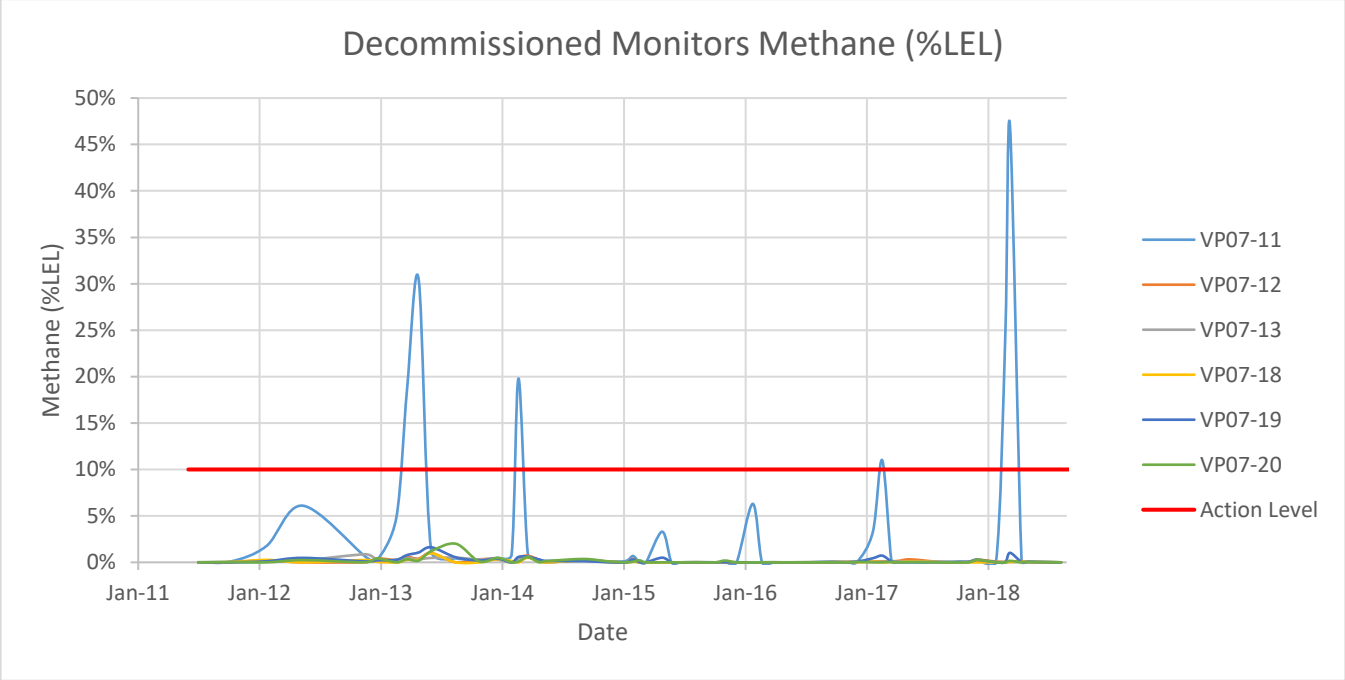

Chart 1: Decommissioned Monitors Methane Concentrations 2011 to 2018

It is inferred that VP07-04 (an existing near-boundary gas monitoring well located near the former location of VP07-11) does not intercept the same landfill gas pathway that VP07-11 did.

2.3.1 Recommended Replacement Landfill Gas Monitoring Wells

It is Golder's understanding that the development to the north of the Landfill property will include residential lots immediately north of the Landfill property. We understand that the owner of the property(ies) north of the Landfill (Tallus Developments Ltd. [Tallus]) has not permitted re-installation of the seven destroyed vapour monitoring wells at the same locations; however, Tallus permitted the potential replacement of the destroyed vapour monitoring wells on the roadway north of the residential development (email and pers. comm.).

It is recommended that VP07-11 be re-installed due to the elevated methane identified in 2017 and 2018; however, RDCO has not received permission to complete this from the property owner due to access constraints and future development activities. Without access to the property(ies) north of the Landfill, Golder recommends installing three replacement landfill gas monitoring wells on the Site, along the north Site boundary, at strategic locations and screened at strategic depths. The following table details the rationale for each recommended replacement monitor, and the proposed approximate locations are shown on Figure 2. Figure 3 provides a series of cross-sections to aid in defining potential lateral landfill gas pathways and to determine the screened depths of the proposed monitors.

Table 2: Rationale and Details for Proposed Replacement Monitors

Proposed Gas MW	Rationale	Potential Screen Details*
VP20-01 and VP20-02	These proposed gas monitoring wells would be installed adjacent to VP07-04 to monitor the potential pathway of methane previously identified at VP07-11 and would be replacements for VP07-11 and VP07-19. These gas monitoring wells would either be nested or installed in close proximity to each other, one well screened at the elevation of VP07-11 and the deeper well screened approximately 5 m below. These would be considered “near boundary monitors” with no step-out monitors present as defined in the 2015 Closure Plan. The elevation of the interface of weathered and competent bedrock at the proposed location of VP20-01/-02 is estimated to be at approximately 545 to 555 masl, and the elevation of screen at VP07-11 is approximately 550 masl.	Propose screening the shallow gas monitoring well at the interface of the weathered and competent bedrock (located at an elevation of approximately 545 to 555 masl) and at the approximate elevation of VP07-11 (screened at 550 masl). The second gas monitoring well would be screened approximately 5 m deeper than the shallow gas monitoring well, at an elevation range of approximately 535 to 545 masl.
VP20-03	Replacement well for VP07-20. Located within the boundaries of the landfill to provide monitoring in the northeast corner of the Westside Landfill. Historically, VP11-09, located south of the proposed well, exhibited elevated concentrations of methane. This would be considered a step-out monitor for VP11-09 and a “near boundary monitor” as defined in the 2015 Closure Plan.	Propose screening the gas monitoring well at the interface of the sand unit and fractured bedrock (located at an elevation of approximately 530 and 540 masl).

masl = metres above sea level

* *The depth of the gas monitoring well screens would be dependent on actual field conditions*.

The above proposed locations and screen details may change based on access restrictions and conditions encountered in the field. It is recommended that each of the proposed replacement monitors outlined in Table 2 are included in the full monthly monitoring events (completed between November and May, and in August). VP201-01 and VP20-02 would also be included in the partial rounds (June, July, September, and October).

2.3.2 Action Level and Action Plan

The 2014 Updated Landfill Monitoring Program set action levels for each of the monitors based on their location and the presence of a step-out monitor; all monitors have an associated action level of 10% LEL except for inside boundary monitors with an associated step-out monitor, which have an action level of 25% LEL. Removal of the monitors outlined in Section 2.2 does not change the associated action level for the remaining monitors. Each of the proposed replacement monitors outlined in Section 2.3 would be assigned an action level of 10% LEL as they are inside boundary monitors with no associated step-out monitor.

The action plan indicates that the first step to take if a methane level is recorded above the associated action level is to check the instrument calibration and recalibrate the instrument if required. If the calibration is deemed inaccurate, the instrument should be re-calibrated, and the monitor should be re-sampled within a 24-hour period. If the calibration is deemed accurate, the next step is assessing the methane concentration in the associated step-out monitor. If there is no associated step-out monitor, or the step-out monitor also exceeds the associated action level, the final step is to notify MoE and develop a specific action plan. No changes to this action plan are recommended at this time.

2.4 Review of Groundwater Monitoring and Sampling Program

Golder conducted a review of the current required groundwater monitoring and sampling requirements to evaluate other revisions and/or potential efficiencies in RDCO's post-closure monitoring requirements outlined in the 2014 Updated Landfill Monitoring Program.

Sections 3.3.3 and 3.3.4 of OC PR#12217 require BH1 and BH4 be sampled every two years for total dissolved solids (TDS), boron, total purgeable hydrocarbons, total extractable hydrocarbons, volatile organics and acid and base/neutral extractable organics, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and phenolics. Groundwater concentrations of these reported parameters[5] have consistently been either below laboratory detection limits or where detectable below applicable standards[6] with the following exceptions:

- $EPH_{(C10-19)}$, $EPH_{(C19-32)}$, LEPH and HEPH: Detectable concentrations reported in BH1 between 2011 and 2019 (not reported prior to 2011).
- PAHs: Concentrations less than the laboratory detection limit (LDL) except for one detected concentration in BH4 in 2019 (for a parameter with no CSR standard).
- BTEX: Detectable concentrations reported in BH1 between 1999 and 2015 (including concentrations greater than the CSR standards) and reported less than the LDL in 2017 and 2019.
- VOCs: Select VOCs reported close to the LDL in BH1 between 1999 and 2011 and reported less than the LDL between 2015 and 2019. Select VOCs reported close to the LDL in BH4 in 1997 and 1999 and reported less than the LDL between 2001 and 2019.
- Chlorinated Hydrocarbons: Concentrations less than the LDL except one detected concentration (equal to the LDL) in BH1 in 2009.
- Base-Neutral Extractables: Detectable concentrations reported in 1997 (BH4) and 2001 (BH1), reported less than the LDL in subsequent years.

Groundwater concentrations of these reported parameters at BH1 and BH4 are provided in attached Table A.

With regards to the groundwater monitoring and sampling requirements stated in Section 3.3.3 and 3.3.4 of OC PR#12217, Golder recommends the following revisions:

- **BH1**: Continue groundwater sampling and analysis every two years at BH1 for EPH, BTEX, VOCs, TDS, BOD and COD. Discontinue analysis at BH1 for all other analyses under Section 3.3.4 of OC PR#12217.
- **BH4**: Discontinue all analysis at BH4 under Sections 3.3.3 and 3.3.4 of OC PR#12217.

[5] Between 1997 and 2019, the laboratory reported the following parameters for these parameters listed in the permit: benzene, toluene, ethylbenzene, xylenes (BTEX), styrene, volatile petroleum hydrocarbons (VPH), extractable petroleum hydrocarbons (EPH), light/heavy extractable petroleum hydrocarbons (LEPH/HEPH), polycyclic aromatic hydrocarbons (PAHs), halogenated volatiles (VOCs), trihalomethanes, chlorinated hydrocarbons, phthalate esters, and base-neutral extractables.

[6] Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, effective 1 April 1997; includes amendments up to B.C. Reg. 13/2019 24 January 2019). Generic Numerical Water Standards for the assessment of groundwater quality (CSR Schedule 3.2) protective of drinking water and freshwater aquatic life.

Following two complete years of post-closure monitoring, it is recommended that the Updated Landfill Monitoring Program monitoring and sampling requirements be re-assessed. As the closure works were completed on 7 November 2018 with the conclusion of the seeding and fertilizing activities at the Site, it is recommended that the Updated Landfill Monitoring Program monitoring and sampling requirements be re-assessed following the completion and submission of the 2020 Monitoring Report.

3.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of this work is to provide updates to the Landfill Monitoring Program for the Westside Landfill to reflect revisions to the landfill gas monitoring program and groundwater monitoring and sampling program. This report should be read in conjunction with the 2013 Landfill Gas Management Plan and 2014 Updated Landfill Monitoring Program prepared for the Site.

Landfill Gas Monitoring Program

It is recommended that the following revisions to the landfill gas monitoring program be made from the requirements provided in the 2014 Updated Landfill Monitoring Program:

- Add the three landfill gas monitoring wells installed in 2015: VP15-01, VP15-02, and VP15-03. It is recommended that VP15-01, VP15-02, and VP15-03 be monitored monthly and included in the partial monitoring events.
- Remove the seven landfill gas monitoring wells decommissioned in 2018: VP07-11, VP07-12, VP07-13, VP07-17, VP07-18, VP07-19, and VP07-20.
- It is recommended that VP07-11 be re-installed due to the elevated methane identified in 2017 and 2018; however, RDCO has not received permission to complete this from the property owner due to access constraints and future development activities. Without access to the property(ies) north of the Landfill, Golder recommends installing three replacement landfill gas monitoring wells along the north side of the Site (VP20-01, VP20-02 and VP20-03). It is recommended that these three replacement landfill gas monitoring wells be monitored in the full monthly monitoring events (completed between November and May, and in August). VP20-01 and VP20-02 would also be included in the partial rounds (June, July, September, and October).

Groundwater Monitoring and Sampling Program

It is recommended that the following revisions to the groundwater monitoring and sampling program be made from the requirements provided in the 2014 Updated Landfill Monitoring Program:

- **BH1**: Continue groundwater sampling and analysis every two years at BH1 for EPH, BTEX, VOCs, TDS, BOD and COD. Discontinue groundwater analysis at BH1 for all other analyses under Section 3.3.4 of OC PR#12217.
- **BH4**: Discontinue all analysis at BH4 under Sections 3.3.3 and 3.3.4 of OC PR#12217.

No other revisions to other components of the Landfill Monitoring Program (i.e., groundwater monitoring, surface water monitoring, site inspection) are proposed until two complete years of post-closure monitoring have been completed.

4.0 LIMITATIONS

This report was prepared for the exclusive use of the Regional District of Central Okanagan (RDCO). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report. The report, which includes all appendices and attachments, is based on data and information collected during the investigation conducted by Golder Associates Ltd.'s personnel and upon third party information provided by the RDCO. The report provides a level of assurance commensurate with the level of study.

Golder has relied in good faith on information provided to us. We accept no responsibility for any deficiency, misstatements or inaccuracies contained in this report as a result of omissions, misinterpretations of fraudulent acts of the persons or agencies interviewed. This work was performed according to current professional standards and practices in the environmental field. If new information is discovered during future work, including excavations, borings or other activities or studies, Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

5.0 CLOSURE

If there are questions regrading the information provided in this letter, please contact the undersigned at your leisure.

Yours very truly,

Golder Associates Ltd.

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Associate, Senior Environmental Engineer

MS/DA/lih

6.0 REFERENCES

Golder Associates Ltd. 2013. Landfill Gas Management Plan, Westside Landfill.

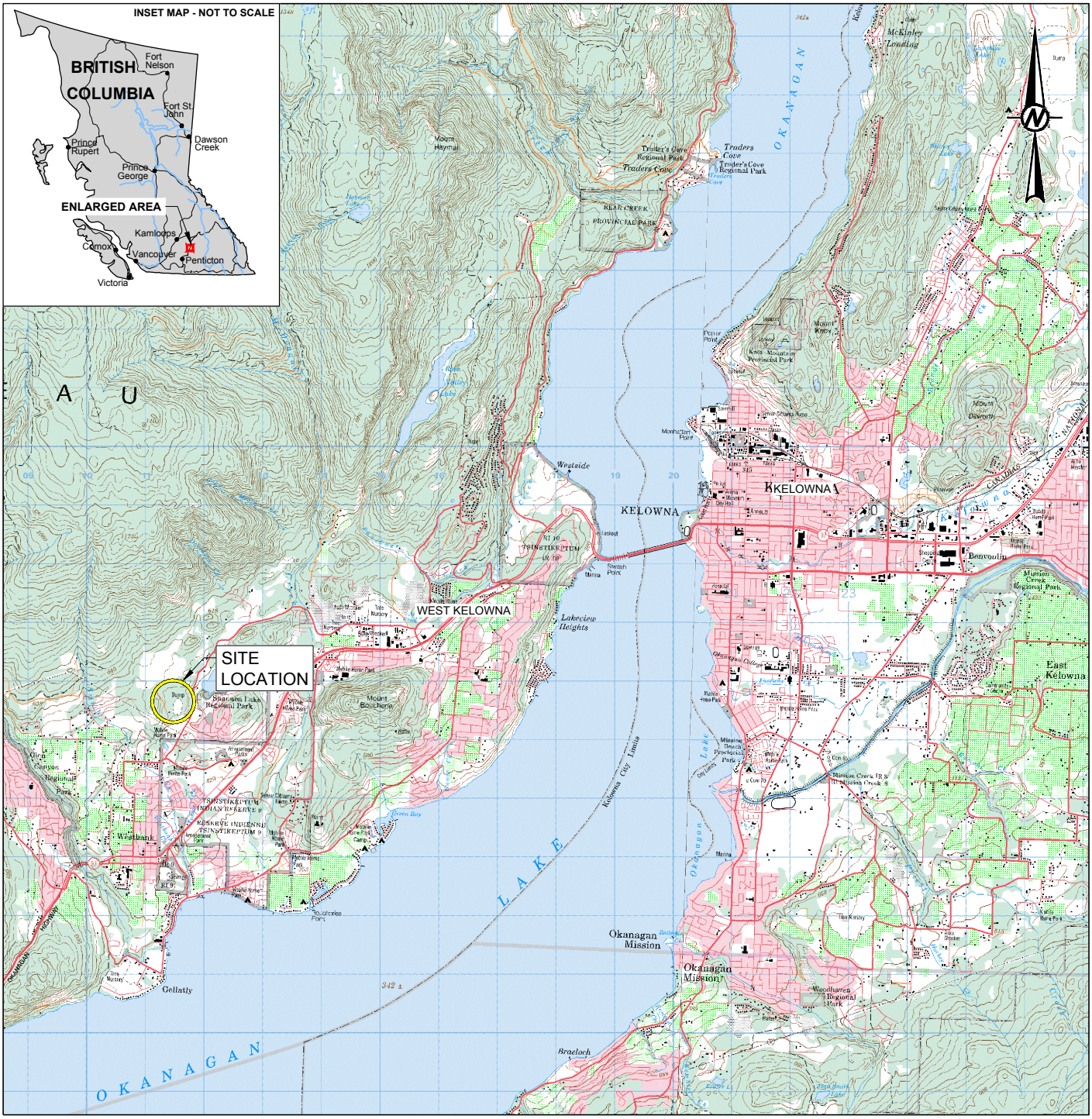
Golder Associates Ltd. 2014. Updated Landfill Monitoring Program, Westside Landfill.

Golder Associates Ltd. 2015. Closure Plan, Westside Landfill, West Kelowna, BC.

Golder Associates Ltd. 2019. 2018 Monitoring Report, Westside Landfill, West Kelowna, BC.

TABLE A
ORGANIC GROUNDWATER CHEMISTRY
WESTSIDE LANDFILL
WEST KELOWNA, BC

Parameter	Units	BH1											BH4										
		Sep-99	Sep-01	Sep-03	Sep-05	Sep-07	Oct-07	Sep-09	Oct-11	Aug-15	May-17	May-19	Jul-97	Sep-99	Sep-01	Sep-03	Sep-05	Sep-07	Sep-09	Oct-11	Aug-15	May-17	May-19
Non-Halogenated Volatiles																							
Benzene	mg/L	0.0014	0.0023	0.0019	0.001	1.3	-	0.0012	0.00091	0.006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.00050	<0.005	<0.0005	<0.0005
Ethylbenzene	mg/L	0.0006	0.0012	<0.0005	<0.0005	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Styrene	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Toluene	mg/L	0.0016	0.0009	<0.0005	<0.001	<0.001	-	<0.0005	<0.0010	<0.0010	<0.001	<0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.005	<0.0010	<0.0010	<0.001	<0.001
meta & para-Xylene	mg/L	<0.0005	0.0008	<0.0005	<0.0005	-	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-
ortho-Xylene	mg/L	<0.0005	0.0006	<0.0005	<0.0005	-	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-
Total Xylenes	mg/L	-	-	-	<0.001	<0.002	-	<0.002	<0.0020	<0.0020	<0.002	<0.002	-	-	-	-	<0.001	`	<0.002	<0.0020	<0.0020	<0.002	<0.002
Light Hydrocarbons (C5-9)	mg/L	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
VPH	mg/L	-	-	-	-	<0.1	-	-	<0.1	-	-	-	<0.1	-	-	-	-	<0.1	-	<0.1	-	-	-
Extractable Petroleum Hydrocarbons																							
LEPH	mg/L	-	-	-	-	-	-	-	0.75	0.295	<0.250	0.272	-	-	-	-	-	-	-	<0.100	<0.100	<0.250	<0.250
HEPH	mg/L	-	-	-	-	-	-	-	0.5	0.293	<0.250	<0.250	-	-	-	-	-	-	-	<0.100	<0.100	<0.250	<0.250
EPH_{C10-19}	mg/L	-	-	-	-	-	-	-	0.75	0.295	<0.250	0.272	-	-	-	-	-	-	-	<0.100	<0.100	<0.250	<0.250
EPH_{C19-32}	mg/L	-	-	-	-	-	-	-	0.5	0.293	<0.250	<0.250	-	-	-	-	-	-	-	<0.100	<0.100	<0.250	<0.250
Polycyclic Aromatic Hydrocarbons																							
Acenaphthene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050
Acenaphthylene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.200	<0.200	-	-	-	-	-	-	-	-	<0.0005	<0.200	<0.200
Acridine	mg/L	-	-	-	-	-	-	-	-	<0.0010	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0010	<0.050	<0.050
Anthracene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.010	<0.010	-	-	-	-	-	-	-	-	<0.0005	<0.010	<0.010
Benz (a) anthracene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.010	<0.010	-	-	-	-	-	-	-	-	<0.0005	<0.010	<0.010
Benzo (a) pyrene	mg/L	-	-	-	-	-	-	-	-	<0.0001	<0.010	<0.010	-	-	-	-	-	-	-	-	<0.0001	<0.010	<0.010
Benzo (b) fluoranthene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	-	-	-	-	-	-	-	-	-	<0.0005	<0.050	-
Benzo(b+j)fluoranthene	mg/L	-	-	-	-	-	-	-	-	-	<0.100	<0.050	-	-	-	-	-	-	-	-	-	<0.100	<0.050
Benzo (g,h,i) perylene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050
Benzo (k) fluoranthene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050
Chrysene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050
Dibenz (a,h) anthracene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.010	-	-	-	-	-	-	-	-	<0.0005	<0.050	0.016
Fluoranthene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.030	<0.030	-	-	-	-	-	-	-	-	<0.0005	<0.030	<0.030
Fluorene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050
Indeno (1,2,3-cd) pyrene	mg/L	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0005	<0.050	<0.050
Naphthalene	mg/L	-	-	-	-	-	-	-	-	<0.0030	<0.200	<0.200	-	-	-	-	-	-	-	-	<0.0030	<0.200	<0.200
Phenanthrene	mg/L	-	-	-	-	-	-	-	-	<0.0010	<0.100	<0.100	-	-	-	-	-	-	-	-	<0.0010	<0.100	<0.100
Pyrene	mg/L	-	-	-	-	-	-	-	-	<0.0010	<0.020	<0.020	-	-	-	-	-	-	-	-	<0.0010	<0.020	<0.020
Quinoline	mg/L	-	-	-	-	-	-	-	-	<0.0010	<0.050	<0.050	-	-	-	-	-	-	-	-	<0.0010	<0.050	<0.050
Halogenated Volatiles																							
Carbon tetrachloride	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	<0.0005	<0.0005
Chlorobenzene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	0.0019	0.0011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	<0.001	<0.001
Chloroethane	mg/L	0.002	0.002	<0.003	0.001	-	-	-	<0.0020	<0.0020	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.0020	<0.0020	<0.002	<0.002
Chloromethane (methyl chloride)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	-	<0.0030			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.0030		
1,2-Dichlorobenzene	mg/L	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.00050	<0.001	<0.00050	<0.00050	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.00050	<0.00050	<0.0005	<0.0005
1,3-Dichlorobenzene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	0.0016	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
1,4-Dichlorobenzene	mg/L	<0.001	0.004	0.004	0.003	<0.001	<0.0010	0.003	0.0018	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
1,1-Dichloroethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
1,2-Dichloroethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
cis-1,2-Dichloroethylene	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	-	-	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	-	-
cis-1,2-Dichloroethylene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	-	-
1,1-Dichloroethylene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	-	-
Dichloromethane	mg/L	<0.01	<0.005	<0.005	<0.005	-	-	-	<0.0030	-	-	-	<0.005	0.007	<0.005	<0.005	<0.005	-	-	<0.0030	-	-	-
1,2-Dichloropropane	mg/L	<0.001	<0.001	<0001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	-	-
cis-1,3-Dichloropropylene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	-	-
trans-1,3-Dichloropropylene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.001	-	-
Methyl tert-butyl ether	mg/L	-	-	-	-	-	-	-	-	<0.0010	<0.001	<0.001	-	-	-	-	-	-	-	-	<0.0010	<0.001	<0.001
1,1,1,2-Tetrachloroethane	mg/L	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.0005	<0.0005
Tetrachloroethylene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
1,1,1-Trichloroethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
1,1,2-Trichloroethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Trichloroethylene	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Trichlorofluoromethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Vinyl chloride	mg/L	<0.001	0.001	0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0020	<0.001	<0.001
Trihalomethanes																							
Bromodichloromethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Bromoform	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Chloroform	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Dibromochloromethane	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.001	<0.001
Chlorinated Hydrocarbons																							
Hexachlorobenzene	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.0006	<0.006	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0006	-	-	-	-	-
Hexachlorobutadiene	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.001	<0.001	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.001	<0.001	-	-	-	-
Hexachloroethane	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.003	<0.003	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.003	<0.003	-	-	-	-
1,2,4-Trichlorobenzene	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.003	0.003	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.003	<0.003	-	-	-	-
Phthalate Esters																							
Benzyl butyl phthalate	mg/L	<0.001	<0.005	<0.005	<0.005	-	<0.005	<0.005	-	-			<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	-	-		
Bis(2-ethylhexyl)phthalate	mg/L	<0.001	<0.005	<0.005	<0.005	-	<0.001	<0.001	-	-			<0.001	0.004	<0.005	<0.005	<0.005	0.003	<0.001	-	-		
di-n-butyl phthalate	mg/L	0.0003	<0.005	<0.005	<0.005	-	<0.001	<0.001	-	-			0.0004	0.0005	<0.005	<0.005	<0.005	0.001	<0.001	-	-		
di-n-octyl phthalate	mg/L	<0.0001	<0.005	<0.005	<0.005	-	<0.001	<0.001	-	-			<0.0001	<0.0001	<0.005	<0.005	<0.005	<0.001	<0.001	-	-		
Diethyl phthalate	mg/L	0.0076	-	<0.05	<0.05	-	<0.003	<0.003	-	-			0.0001	0.0004	-	<0.05	<0.05	<0.003	<0.003	-	-		
Dimethyl phthalate	mg/L	<0.0001	<0.05	<0.05	<0.05	-	<0.003	<0.003	-	-			<0.0001	<0.0001	<0.05	<0.05	<0.05	<0.003	<0.003	-	-		
Base-Neutral Extractables																							
Bis(2-chloroethoxy)methane	mg/L	<0.0003	<0.0001	-	<0.0004	-	<0.0008	<0.008	-	-	-	-	<0.0001	<0.001	<0.0001	-	<0.0001	<0.0008	<0.0008	-	-	-	-
Bis(2-chloroethyl)ether	mg/L	<0.0002	<0.0001	-	<0.0001	-	<0.0006	<0.0006	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0006	<0.0006	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.002	<0.002	-	-	-	-	<0.0001	<0.0002	<0.0001	-	<0.0001	<0.002	<0.002	-	-	-	-
4-Bromophenyl phenyl ether	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.006	<0.0006	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0006	<0.0006	-	-	-	-
2-Chloronaphthalene	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.0008	<0.0008	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0008	<0.0008	-	-	-	-
4-Chlorophenyl phenyl ether	mg/L	<0.0001	<0.0001	-	<0.0001	-	<0.0007	<0.0007	-	-	-	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0007	<0.0007	-	-	-	-
2,4-Dinitrotolune (2,4-DNT)	mg/L	<0.0004	0.0004	<0.0006	<0.0003	-	<0.0005	<0.0005	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	-	-	-	-
2,6-Dinitrotoluene (2,6-DNT)	mg/L	<0.0008	<0.0001	<0.002	<0.0004	-	<0.0005	<0.0005	-	-	-	-	0.0002	<0.002	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	-	-	-	-
Isophorone	mg/L	<0.0001	<0.0001	<0.0002	<0.0001	-	<0.0006	<0.0006	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0006	<0.0006	-	-	-	-
Nitrobenzene (NB)	mg/L	<0.0005	<0.0001	<0.002	<0.0005	-	<0.0007	<0.0007	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0007	<0.0007	-	-	-	-
n-Nitrosodi-n-propylamine	mg/L	<0.0001	<0.0001	<0.002	<0.0005	-	<0.0006	<0.0006	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	<0.0006	<0.0006	-	-	-	-
n-Nitrosodiphenylamine	mg/L	<0.0001	<0.0001	<0.0003	<0.0002	-	<0.0008	<0.0008	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0008	<0.0008	-	-	-	-



REFERENCE

1. TOPOGRAPHIC MAPS 82E/13 AND /14 © 2001 AND 1999 HER MAJESTY THE QUEEN IN RIGHT OF CANADA. DEPARTMENT OF NATURAL RESOURCES. ALL RIGHTS RESERVED.
   PROJECTION: TRANSVERSE MERCATOR DATUM: NAD83
   COORDINATE SYSTEM: UTM ZONE 10

0 2,500 5,000
1:100,000 METRES

CLIENT
REGIONAL DISTRICT OF CENTRAL OKANAGAN (RDCO)

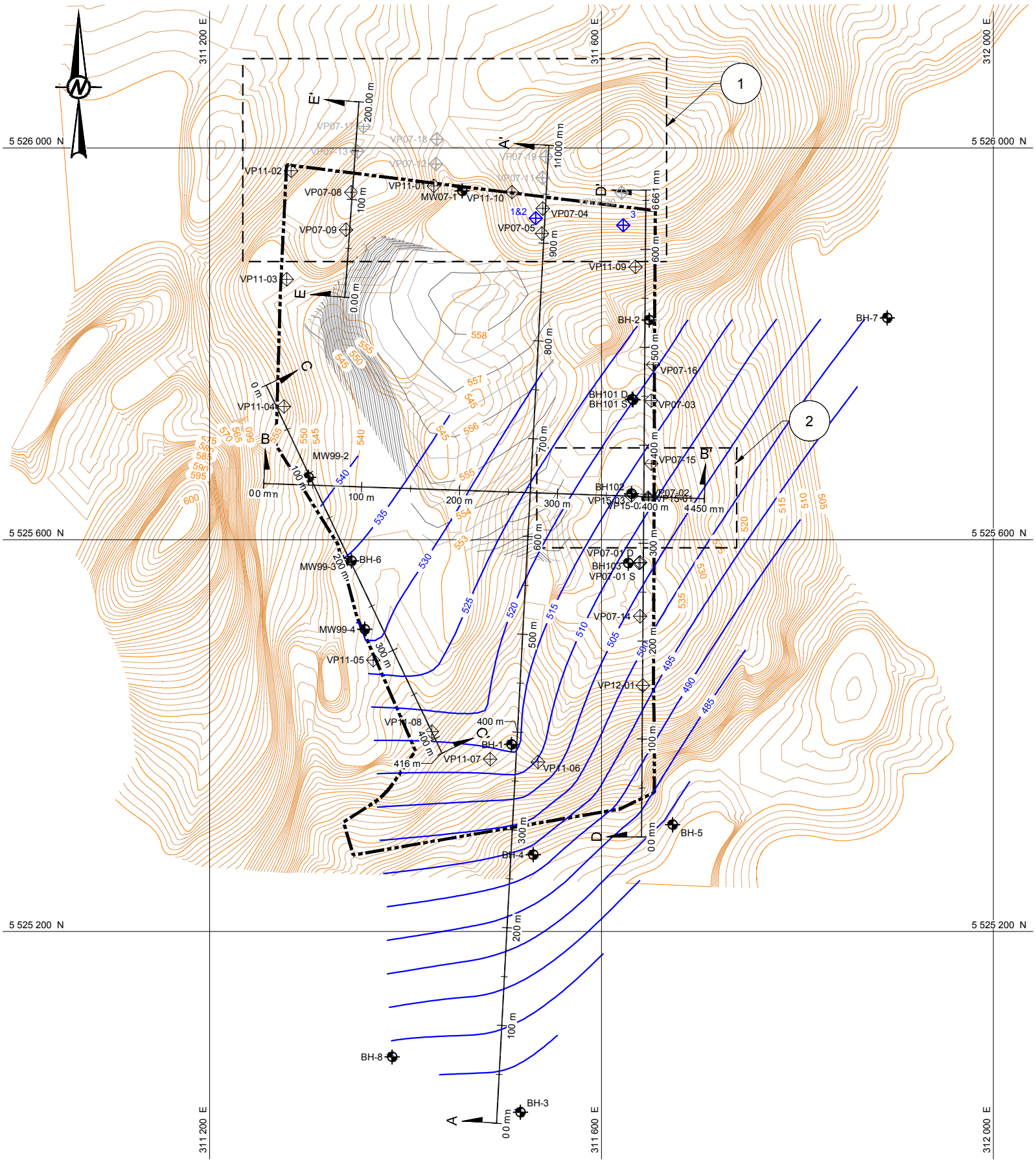
CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-01
PREPARED	R. MARTIN
DESIGN	M. SCHERER
REVIEW	M. SCHERER
APPROVED	D. ATKINSON

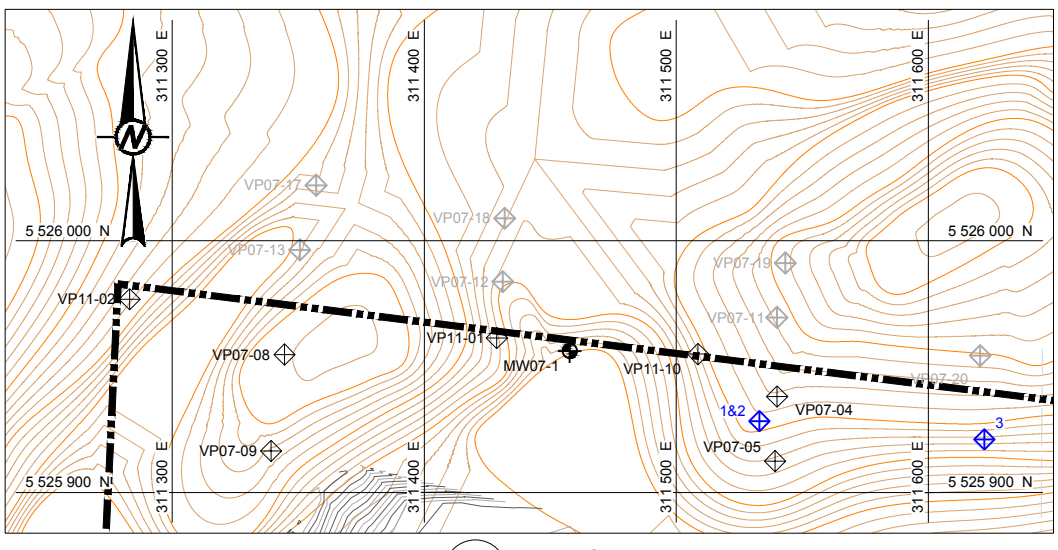
PROJECT
UPDATED LANDFILL MONITORING PROGRAM
WESTSIDE LANDFILL
WEST KELOWNA, B.C.

TITLE
KEY PLAN

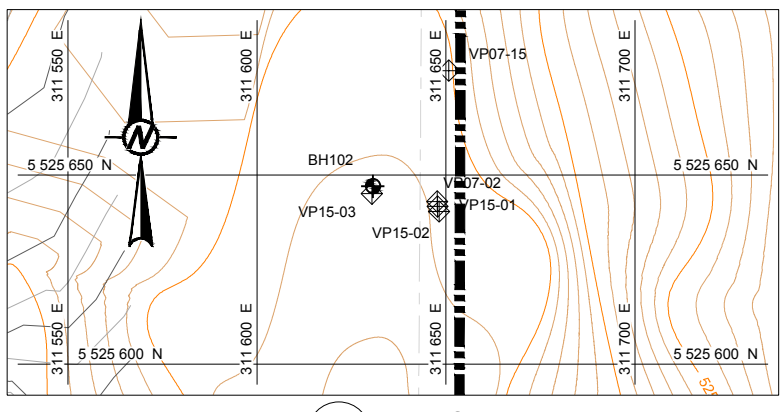
PROJECT No.	PHASE/DOC#	Rev.	FIGURE
19127217	7000/001	0	1



SITE PLAN
SCALE 1:5000



SCALE 1:3000 1 ENLARGED AREA 1



SCALE 1:2000 2 ENLARGED AREA 2

LEGEND

- APPROXIMATE LANDFILL BOUNDARY
- 1972 MAJOR TOPOGRAPHIC CONTOUR (INTERVAL = 5 m)
- 1972 MINOR TOPOGRAPHIC CONTOUR (INTERVAL = 1 m)
- 2018 MAJOR TOPOGRAPHIC CONTOUR (INTERVAL = 5 m)
- 2018 MINOR TOPOGRAPHIC CONTOUR (INTERVAL = 1 m)
- GROUNDWATER CONTOUR (INTERVAL = 5 m) (AUGUST 5th, 2018)
- BOREHOLE/MONITORING WELL LOCATION
- VAPOUR PROBE LOCATION
- VAPOUR PROBE (DESTROYED) LOCATION
- PROPOSED VAPOUR PROBE LOCATION

NOTES

1. ALL UNIT IN METRES UNLESS OTHERWISE STATED.
2. COORDINATES ARE IN UTM NAD83, ZONE 10.

0 50 100
1:2,000 METRES

0 50 100
1:3,000 METRES

0 100 200
1:5,000 METRES

CLIENT
REGIONAL DISTRICT OF CENTRAL OKANAGAN (RDCO)

PROJECT
UPDATED LANDFILL MONITORING PROGRAM
WESTSIDE LANDFILL
WEST KELOWNA, B.C.

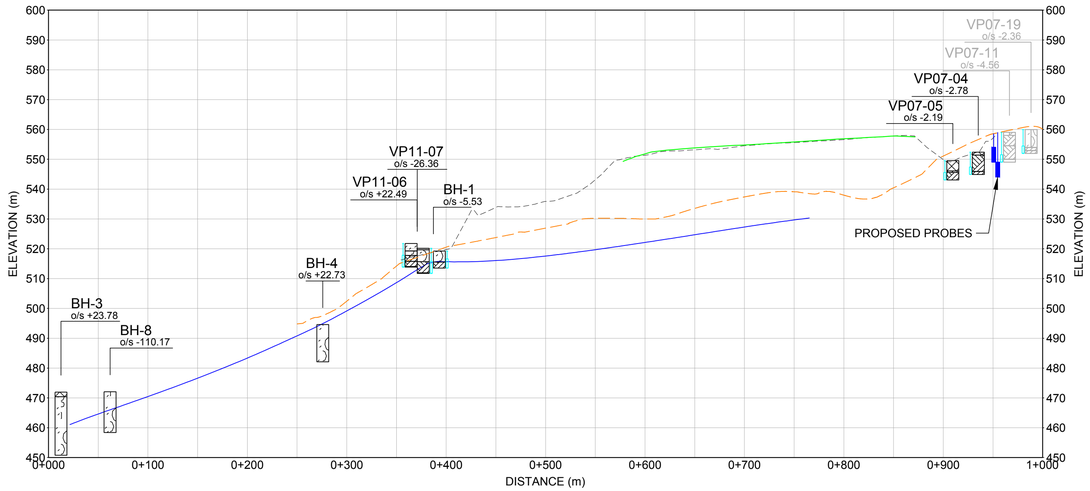
TITLE
SITE PLAN

CONSULTANT
GOLDER

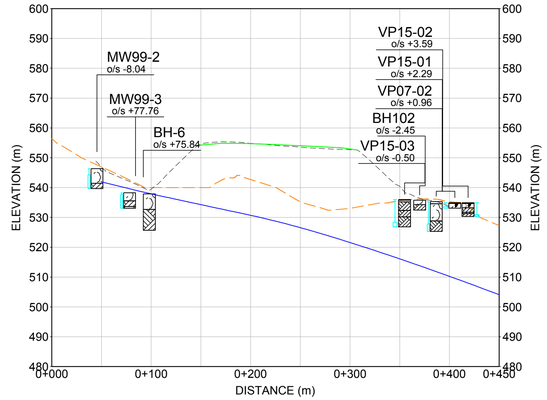
YYYY-MM-DD	2020-05-21
DESIGNED	M. SCHERER
PREPARED	R. MARTIN
REVIEWED	M. SCHERER
APPROVED	D. ATKINSON

PROJECT NO.	PHASE/DOC#	REV.	FIGURE
19127217	7000/001	0	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 mm

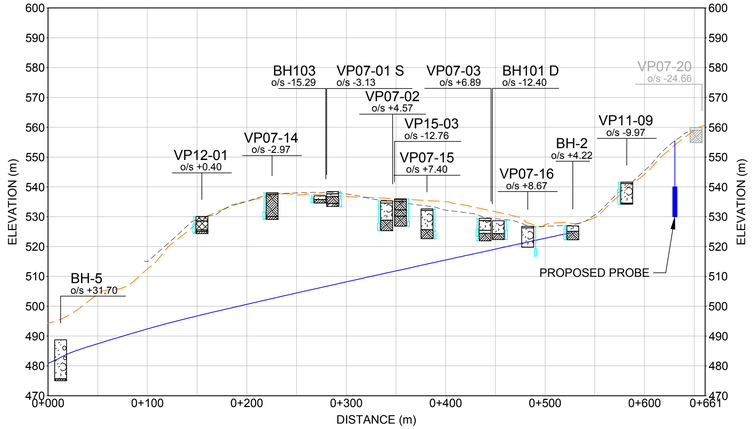


PROFILE A-A

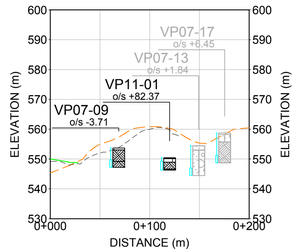


PROFILE B-B

PROFILE C-C



PROFILE D-D



PROFILE E-E

LEGEND

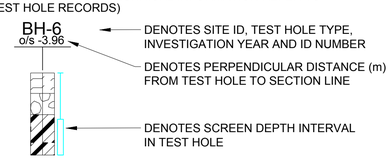
- 1972 GROUND SURFACE
- 2013 GROUND SURFACE
- 2018 GROUND SURFACE
- GROUNDWATER ELEVATION (AUGUST 5th, 2018)

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE STATED.

TEST HOLE RECORD

TEST HOLE RECORD SHOWING SOIL CONDITIONS
(FOR DETAILED GEOTECHNICAL INFORMATION REFER TO TEST HOLE RECORDS)



GRAPHICS FOR TEST HOLES

FILL	PEAT	TOPSOIL
BEDROCK	SAND (SP)	CLAY (CL)
GRAVEL (GP)	SAND (SW)	CLAY (CH)
SILTY SAND (SM)	ORGANICS (OL)	CLAY (CI)
SILT (ML)	SILT (MH)	

* VARIOUS COMBINATIONS OF THE ABOVE SYMBOLS HAVE BEEN USED TO REPRESENT MIXTURES OF THE ABOVE MATERIALS.

VERTICAL: 0 — 50 — 100 METRES (1:1,000)

HORIZONTAL: 0 — 100 — 200 METRES (1:3,000)

CLIENT
REGIONAL DISTRICT OF CENTRAL OKANAGAN (RDCO)

PROJECT
UPDATED LANDFILL MONITORING PROGRAM
WESTSIDE LANDFILL
WEST KELOWNA, B.C.

TITLE
CROSS-SECTIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-06-08
DESIGNED	M. SCHERER
PREPARED	R. MARTIN
REVIEWED	M. SCHERER
APPROVED	D. ATKINSON

PROJECT NO.	PHASE/DOC#	REV.	FIGURE
19127217	7000/001	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25mm

APPENDIX A

Westside Landfill Operational Certificate Letter

Environmental Management Act Approval of Closure Plan for Westside Landfill (Authorization 122217), 6 September 2017

POLLUTION
PREVENTION

Suite 201
3547 Skaha Lake Road
Penticton
British Columbia V2A 7K2
Telephone: (250) 490-8200
Fax: (250) 492-1314

BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

OPERATIONAL CERTIFICATE
PR 12217

Under the provisions of the Waste Management Act and in accordance with the Approved Regional District of Central Okanagan Solid Waste Management Plan,

Regional District of Central Okanagan

1450 KLO Road

Kelowna, British Columbia

V1W 3Z4

is authorized to manage recyclable materials and to discharge refuse to the ground at a landfill facility located approximately 2.5 km north of Westbank, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Waste Management Act* and may result in prosecution.

1 AUTHORIZED DISCHARGES

1.1 The discharge of refuse to which this Sub-Section is applicable is shown on the attached Site Plan A. The reference number for this discharge is E223888.

1.1.1. The maximum rate at which refuse may be discharged to the landfill is 20,000 tonnes per year.

1.1.2 The type of refuse which may be discharged is municipal solid waste and other wastes as authorized by the Regional Waste Manager.

1.1.3 The works authorized are a sanitary landfill and related appurtenances.

1.1.4 The location from which the discharge originates is generally the area on the west side of Okanagan Lake within the boundaries of the Regional District of Central Okanagan.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Date Issued: May 28, 1997
Amendment Date:
(most recent)

1.1.5 The location of the approximate area of discharge is that Part of District Lot 3794 ODYD shown on Plan C11135 Except Plan KAP46607 as shown on Site Plan A.

2 GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

The holder of the Operational Certificate shall inspect the landfill, any related pollution control works and designated areas for managing recyclable or reusable materials regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the holder of the Operational Certificate which prevents continuing operation of the authorized method of pollution control, the holder of the Operational Certificate shall immediately notify the Regional Waste Manager and take appropriate remedial action.

2.2 Process Modifications

The holder of the Operational Certificate shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.3 Plans - New Works

Plans and specifications of any new works related to this facility shall be submitted to the Regional Waste Manager and his consent obtained before construction commences. The works shall be constructed in accordance with such plans. Review of the submitted plans and specifications is for the purpose of administration of the Operational Certificate and only implies that the works specified therein meet the appropriate guidelines, criteria or standards.

2.4 Operational and Closure Plan

2.4.1 An *Operational and Closure Plan*, prepared by a suitably qualified professional shall be submitted for authorization by the Regional Waste Manager, on or before July 31, 1997.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

2.4.2 The *Operational and Closure Plan* shall include the following:

- Anticipated total waste volumes and tonnage, and life of the landfill (ie: closure date);
- A topographic plan showing the final elevation contours of the landfill and surface water diversion and drainage controls;
- Design of the final cover including the thickness and permeability of barrier layers and drainage layers, and information on topsoil, vegetative cover and erosion prevention controls;
- Procedures for notifying the public about the closure and about alternative waste disposal facilities;
- Rodent and nuisance wildlife control procedures;
- Proposed end use of the property after closure;
- A plan for monitoring groundwater, surface water and landfill gas, erosion and settlement for a minimum post-closure period of 25 years;
- A plan and accompanying design for the collection, storage and treatment/use of landfill gas for a minimum of 25 years;
- A plan for operation of any required pollution abatement engineering works such as leachate collection and treatment systems, for a minimum post-closure period of 25 years;
- A schedule of reserve funds or security to be collected each year until closure; to cover estimated costs of closure, post-closure and a contingency for remediation;
- A screening plan, ie: vegetative or berm, designed by a landscape architect with particular focus on the east side of the landfill;
- A detailed fill plan for the east side of the landfill;
- A perimeter and electric bear control fencing design;
- Litter and odour control measures;
- Design of gas monitoring wells for lateral migration and the proposed gas monitoring program;
- Final cover design and a schedule to cover previously filled areas that are no longer going to receive waste, particularly on the east side of the landfill;
- Contingency plan & notification procedures in the event of an emergency;
- Training procedures for operators; and
- Any other site specific concerns as identified by the Regional Waste Manager.

2.4.3 Terms of reference for the Operational and Closure Plan are subject to authorization by the Regional Waste Manager.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Date Issued: May 28, 1997
Amendment Date:

2.4.4 The Regional Waste Manager may request revisions to the *Operational and Closure Plan*. Terms of reference for the revisions to the *Operational and Closure Plan* are subject to authorization by the Regional Waste Manager.

2.4.5 Operation of this landfill is to be in substantial accordance with the authorized *Operational and Closure Plan*.

2.4.6 If there is an inconsistency between this Operational Certificate and the authorized *Operational and Closure Plan*, the Operational Certificate shall take precedence.

2.5 Ground and Surface Water Quality Impairment

2.5.1 Landfills must not be operated in a manner such that ground or surface water quality decreases beyond that allowed by the *Approved and Working Criteria for Water Quality* dated 1995 prepared by the Water Quality Branch of the Ministry of Environment, Lands and Parks at or beyond the landfill property boundary. The appropriate water quality criteria will be specified by the Regional Waste Manager after reviewing uses of the ground and surface water resources.

2.5.2 If excursions result to the specified water quality criteria, the Regional Waste Manager may require that leachate management control measures or works be undertaken. Terms of reference for any leachate management study and/or design work is subject to the authorization of the Regional Waste Manager.

2.6 Landfill Gas Management

2.6.1 An assessment of the emissions of non-methane organic compounds (NMOCs) is required for landfills exceeding a total capacity of 100,000 tonnes. If NMOCs are determined to exceed 150 tonnes/year, landfill gas recovery and management systems will be required to be designed, installed and operational within 3 years. If NMOCs are projected to be less than 150 tonnes/year for the operating life of the landfill, an assessment for the need of passive gas venting will be required. Terms of reference for any landfill gas study or design is subject to the authorization of the Regional Waste Manager.

2.6.2 The gas monitoring wells, designed by a suitably qualified professional, are to be installed on or before August 31, 1998.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Date Issued: May 28, 1997
Amendment Date:
(most recent)

2.7 Property Boundary

The buffer zone between any municipal solid waste discharged after the issuance of this Operational Certificate and the property boundary is to be at least 50 metres of which the 15 metres closest to the property boundary must be reserved for natural or landscaped screening (berms or vegetative screens). Depending on adjacent land use and environmental factors, buffer zones of less than 50 metres but not less than 15 metres may be authorized by the Regional Waste Manager.

2.8 Other Facilities

The distance between the discharged municipal solid waste and the nearest residence, water supply intake, hotel, restaurant, food processing facility, school, church or public park is to be a minimum of 300 metres. Greater or lesser separation distances may be authorized where justified. For those landfills designed to collect and recover methane gas generated, the issue of potential on-site or off-site users of the energy should be addressed in siting the landfill, consistent with the preceding regarding public places. An exemption is granted to discharge municipal solid waste closer than 300 m to the existing residences located in the subdivision to the east of the landfill.

2.9 Natural Control Landfill

2.9.1 The bottommost solid waste cell is to be at least 1.2 metres above the seasonal high water table. Greater or lesser separation depths may be authorized based on soil permeability and the leachate renovation capability of the soil.

2.9.2 There is to be at least a 2 metres thick layer of low permeability soil with a hydraulic conductivity of 1 x 10-6 cm/s or less (i.e. silt or clay), below each of the bottommost waste cells. Lesser thicknesses or no layer of low permeability soil may be authorized based on the potential for leachate generation and the unsaturated depth, permeability and leachate renovation capability of the existing soil.

2.10 Water

The disposal of municipal solid waste into water is unacceptable. Surface water diversion to restrict storm water runoff from contacting the wastes is required.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Date Issued: May 28, 1997
Amendment Date:

2.11 Final Cover

Final cover for landfill sites is to consist of a minimum of 1 metre of low permeability (<1 x 10-5 cm/s) compacted soil plus a minimum of 0.15 metre of topsoil with authorized vegetation established. The depth of the topsoil layer should be related to the type of vegetation proposed (ie rooting depth). Soils of higher permeability may be authorized based on leachate generation potential at the landfill site. Final cover is to be constructed with slopes between 4% and 33% with appropriate run-on/run-off drainage controls and erosion controls. An assessment of the need for gas collection and recovery systems shall be made so that, in the event such systems are required, cover can be appropriately designed and constructed. Final cover is to be installed within 90 days of landfill closure or on any areas of the landfill which will not receive any more refuse within the next 12 months. Completed portions of the landfill are to progressively receive final cover during the active life of the landfill.

Additional layers of natural materials including earth and aggregate and/or synthetic materials may be necessary for inclusion in the final cover design due to site specific conditions and the presence of management systems for leachate and landfill gas.

2.12 Access Road

An appropriately constructed and maintained access road to, and a road system within the landfill site capable of supporting all vehicles hauling waste, are required during the operating life of the landfill.

2.13 Fencing and Access

2.13.1 Fencing is required to be installed around the perimeter of the landfill on or before April 1, 1998. The type and extent of fencing will depend on the existing natural vegetation and topographic features and is to be authorized by the Regional Waste Manager. All access points are to have locking gates.

2.13.2 Bears shall be prevented from accessing any and all putrescible refuse from April to November inclusive through the use of electric fencing. Electric fencing is to be installed on or before April 1, 1998 and maintained thereafter.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

2.13.3 The holder of the Operational Certificate is to conduct a public relations campaign 3 months prior to the installation of electric fencing. The purpose of the campaign is to inform the public of the impacts of installing electric fencing around the landfill. The Conservation Officer Service is to be consulted in the development of the public relations campaign.

2.13.4 Signage is to be attached to the electric fence at regular intervals with an appropriate safety warning indicating that the fence is electrified.

2.14 Design by Qualified Persons

All landfills are to be designed by persons qualified in landfill site selection, design and operation. All plans, specifications, and reports are to be sealed by a professional engineer or geoscientist licensed to practice in the province of British Columbia.

2.15 Prohibited Wastes

The co-disposal of the following wastes with the rest of the municipal solid waste is prohibited unless specifically authorized by the Regional Waste Manager:

- Special Wastes other than those specifically authorized in the *Special Waste Regulation*
- Bulk liquids and semisolid sludges which contain free liquid;
- Liquid or semisolid wastes including septage, black water, sewage treatment sludge, etc.;
- Automobiles, white goods, other large metallic objects and tires;
- Biomedical waste as defined in the document *Guidelines for the Management of Biomedical Waste in Canada* (CCME, February 1992); and
- Dead animals and slaughter house, fish hatchery and farming wastes or cannery wastes and byproducts.

Burial of these wastes in dedicated locations (i.e. avoiding co-disposal) at a landfill site may be authorized by the Regional Waste Manager only if there is no other viable alternative such as treatment/disposal, recycling, reprocessing or composting. The viability of alternatives is to be determined by the Regional Waste Manager based on submission of cost data by the holder of the Operational Certificate. For those cases in which the dedicated disposal of otherwise prohibited wastes is authorized, the specific on-site location of the disposal shall be recorded to allow ready access to the waste should corrective or further action pertaining to the management of these wastes be required by the Ministry at some time in the future.

2.16 Hydrocarbon Contaminated Soils

The deposit of hydrocarbon contaminated soils below the *Special Waste Regulation* criteria is authorized at this landfill subject to the following conditions:

- Soil contaminated with hydrocarbons shall be deposited in layers less than 0.3 meters; and

- Soil contaminated with hydrocarbons shall be deposited a minimum of 1.2 meters above the seasonal high groundwater level and a minimum of 2.0 meters below the final grade of the landfill to prevent the impact on groundwater and any future vegetation on the site.

2.17 Designated Areas

Maintain areas for the separation, handling and storage of recyclable or reusable materials where applicable.

When a separated recyclable material is a special waste it is to be stored and managed in accordance with the *Special Waste Regulation*.

Composting of yard waste is to be in accordance with the *Production and Use of Compost Regulation*.

2.18 Signs

A sign is to be posted at each entrance of the landfill with the following current information:

- Site name
- Owner and operator
- Contact phone number and address for owner and operator
- Phone number in case of emergency (such as fire)
- Hours of operation (if applicable)
- Materials/wastes accepted for landfill and recycling
- Materials/wastes banned
- Tipping fees (if applicable)

Additional signs which clearly indicate the directions to the active tipping face, public disposal area, recycling and waste separation areas, etc. should also be displayed.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

2.19 Supervision

Fulltime, trained operators on-site are required at this landfill during operating hours. The gates are to be locked to prevent unauthorized access during non-operating hours. Properly designed and maintained public waste disposal and/or recyclable material bins situated outside the main gate may be provided for after hours use. The operator is required to be familiar with the Operational Certificate, inspection records, the authorized *Operations and Closure Plan* and all annual reports.

2.20 Scavenging

Scavenging of waste is to be prevented. The salvaging of wastes should be encouraged by providing areas and facilities for separation of recyclable or reusable materials.

2.21 Dust Control

Dust created within the landfill property is to be controlled, using methods and materials acceptable to the Regional Waste Manager, such that it does not cause a public nuisance.

2.22 Waste Compaction and Covering

2.22.1 Wastes are to be spread in thin layers (0.6 m or less) on the working face and compacted. The working face area should be minimized as much as possible. A compacted layer of cover material of at least 0.15 metre of soil or functionally equivalent depth of other cover material, as authorized by the Regional Waste Manager, is to be placed on all exposed solid waste at the end of each day of operation. If the landfill should operate continuously 24 hours per day, 0.15 m of cover material is to be applied at a frequency authorized by the Regional Waste Manager. Under specific circumstances, such as during bear season, the Regional Waste Manager may specify more stringent cover requirements. During periods of extreme weather conditions, such as those that cause the ground to freeze, an exemption to the normal cover requirements may be authorized at a frequency authorized by the Regional Waste Manager.

2.22.2 An intermediate cover consisting of a compacted layer of at least 0.30 metre of soil or functionally equivalent depth of other cover material is to be placed where no additional solid waste has been deposited or will be deposited within a period of 30 days.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

2.23 Litter Control

Litter is to be controlled by compacting the waste, minimizing the working face area, applying cover, providing litter control fences and instituting a regular litter pickup and general good housekeeping program or any other measures required by the Regional Waste Manager.

2.24 Vectors

Vectors are to be controlled by the application of cover material at a specified frequency or by other control measures as required and authorized by the Regional Waste Manager.

2.25 Wildlife

The landfill is to be operated so as to minimize the attraction of wildlife such as bears and birds by applying cover at required frequencies and instituting a good housekeeping program. Further control measures, such as bear control fences, and bird control devices, may be specified by the Regional Waste Manager.

2.26 Fire Protection

Adequate fire fighting equipment is to be available to extinguish surface or underground fires. Recyclables and reusable materials are to be stored in such a manner to not constitute a fire hazard.

3 MONITORING AND REPORTING REQUIREMENTS

3.1 Municipal Solid Waste Measurement

3.1.1 Provide and maintain a weigh scale and record the weight of refuse discharged to the landfill over a 24-hour period.

3.1.2 Record the weight of recyclable and reusable materials not being discharged and that are being separated, stored or processed at the landfill over a 24-hour period.

3.1.3 Density tests are to be performed utilizing a known scaled volume of representative compacted refuse at a frequency of at least once per year and reported in kg per m3.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

3.2 Water Levels

Measure the water level and determine the elevation, on a quarterly basis, in monitoring wells BH1 (E224611), BH2 (E224612), BH4 (E224617), BH5 (E224618), BH6 (E224620), BH7 (E224621), BH8 (E224623) and Dobbin's Well (E224624) as shown on Site Plan B.

3.3 Water Quality

3.3.1 Install a suitable sampling facility and obtain a grab sample on a quarterly basis, of the groundwater, in monitoring wells BH1 (E224611), BH2 (E224612), BH4 (E224617), BH5 (E224618) and Dobbin's Well (E224624) as shown on Site Plan B.

3.3.2 Obtain analyses of the samples in section 3.3.1 for the following:

conductivity, total alkalinity ($CaCO_3$), chloride, sulphate, ammonia nitrogen, nitrate nitrogen, aluminum, antimony, arsenic, barium, beryllium, bismuth, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorous, potassium, selenium, strontium, thallium, tin, titanium, tungsten, vanadium, and zinc.

3.3.3 Obtain grab samples, every two years, of the groundwater in monitoring wells BH1 (E224611) and BH4 (E224617) as shown on Site Plan B.

3.3.4 Obtain analyses of the samples in section 3.3.3 for the following:

total dissolved solids, boron, total purgeable hydrocarbons, total extractable hydrocarbons, volatile organics (EPA 624) and acid and base/neutral extractable organics (EPA 625) , BOD, COD, and phenolics.

3.3.5 Obtain suitable grab samples, on an annual basis, of the groundwater in all domestic water wells being used for drinking water purposes within 1000m down-gradient of the landfill subject to obtaining permission from the water well owner.

3.3.6 Obtain analyses of the samples in section 3.3.5 for conductivity and chloride.

Date Issued: May 28, 1997
Amendment Date:

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

3.4 Vegetation Monitoring

Inspect vegetation during the growing season in the vicinity of the landfill at least once per year to determine if any environmental impacts are occurring.

3.5 Sampling and Analytical Requirements

3.5.1 The sampling and monitoring requirements specified above shall be carried out in accordance with the appropriate procedures listed in the table below. Alternative test methods may be used provided that the alternative test methods are authorized by the Regional Waste Manager prior to performing the actual source testing. Test methods for parameters not listed below require the consent of the Regional Waste Manager.

DISCHARGES TO AIR, AMBIENT AIR:		
Parameter	Source Testing Procedure	Analytical Procedure
Particulate Matter Rate of Discharge (flow rate) Gaseous emissions	Stationary Emission Testing Code - contained in British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 1996 Permittee Edition	A Laboratory Manual for the Chemical Analysis of Ambient Air, Emissions, Precipitation, Soil and Vegetation, 3rd edition, April, 1983, 253 pp.
LIQUID EFFLUENTS, SURFACE WATER, GROUND WATER, SOILS, SEDIMENTS, VEGETATIVE MATTER:		
Parameter	Source Testing Procedure	Analytical Procedure
Metals Nutrients Organics Toxicity	British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 1996 Permittee Edition	British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, March, 1994, Permittee Edition

The above manuals are available from Queen's Printer Publications Centre, P.O. Box 9452, Stn. Prov. Govt, Victoria, BC, V8W 9V7 (1-800-663-6105 or (250) 387-4609). The above manuals are also available for inspection at all Pollution Prevention offices.

3.5.2 Proper care should be taken in sampling, storing and transporting the samples to adequately control temperature and avoid contamination and breakage.

3.5.3 Maintain the groundwater monitoring wells including provisions to ensure protection from damage due to vehicles or vandalism.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Date Issued: May 28, 1997
Amendment Date:
(most recent)

3.5.4 Groundwater monitoring wells are to be covered with lockable caps, fitted with locks all keyed alike, and a key is to be provided to the Regional Waste Manager.

3.5.5 Three well bore volumes are to be pumped from each monitoring well prior to sample collection.

3.6 Changes to Sampling and Monitoring Program

On the basis of findings during routine inspections and any other information related to the effect of the discharge on the receiving environment, the Regional Waste Manager may allow reductions or require additional sampling and monitoring of the discharge and receiving environment.

3.7 Annual Report

An annual operations and monitoring report is to be submitted to the Regional Waste Manager within 60 days of the end of the calendar year. The first annual report is due on March 1, 1998. These reports are to contain at least the following information:

- Total volume and/or weight of waste discharged into the landfill for the year;
- Service population and waste discharge rate for the year (in tonnes per capita per year) and a trend analysis with a comparison to the 1990 baseline waste discharge rate of 1.20 tonnes per capita per year ;
- Authorized design volume;
- Remaining site life and capacity;
- Operational plan for next 12 months;
- Operation and maintenance expenditures;
- Monitoring data compilation, interpretation and trend analysis prepared by a suitably qualified professional regarding landfill gas, vegetation and leachate/water quality including a review of groundwater elevations and flow direction and a comparison made to the drinking water parameters found in the *Approved and Working Criteria for Water Quality* dated April 1995.;
- Amounts of leachate collected, treated and disposed;
- Any changes from authorized reports, plans and specifications;
- any changes to the contingency plan;
- Amount of landfill gas collected and its disposition;
- Review of the closure plan and associated estimated costs, including an update of the schedule of reserve funds or security to be collected each year until closure;. to cover estimated costs of closure, the 25 year post-closure period and a contingency for remediation; and
- Any other data relevant to this Operational Certificate

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

3.8 Format of Submission

Monitoring and/or reporting information shall be submitted in an electronic and/or printed format which is suitable for review by the public and/or other government agencies and is satisfactory to the Regional Waste Manager.

3.9 Financial Security

Provide a future financial security of the operations at and beyond closure by establishing a Closure Fund in a form acceptable to the Regional Waste Manager, such as upfront security or a fund financed on a charge per tonne of waste disposed basis. Such a fund would be analogous to the provincial Waste Management Trust Fund which the Minister may establish under Section 53 of the *Waste Management Act*. The ultimate amount of the financial security shall meet or exceed the currently estimated closure and post-closure costs as outlined in the closure plan plus a reasonable contingency for any remediation which may be required. For municipally owned landfills, the financial security can be built up over time according to a schedule authorized by the Regional Waste Manager.

3.10 Legal Survey

Landfills sited on titled land must register a covenant that the property was used for the purpose of waste disposal as a charge against the title to the property as provided for under Section 215.1 of the *Land Title Act*. Landfills located on crown land are to have a "notation on file" registered that the property was used for the purpose of waste disposal.

3.11 Buildings and Structures

The construction of buildings and other structures on landfills containing putrescible wastes is not recommended for a minimum period of 25 years after closure due to concerns about combustible gas and excessive settlement. Such activity will only be considered and /or authorized after an investigation and report by qualified persons. The report is to be submitted for authorization to the Regional Waste Manager prior to initiating construction activities.

3.12 Operation of Gas Recovery and Management System

Where landfill gas recovery and management is required, operation of the system should be considered an integral part of overall landfill management. The system should be planned for from the early design stage of the landfill and arrangements made for its operation for a minimum 25 year life after closure.

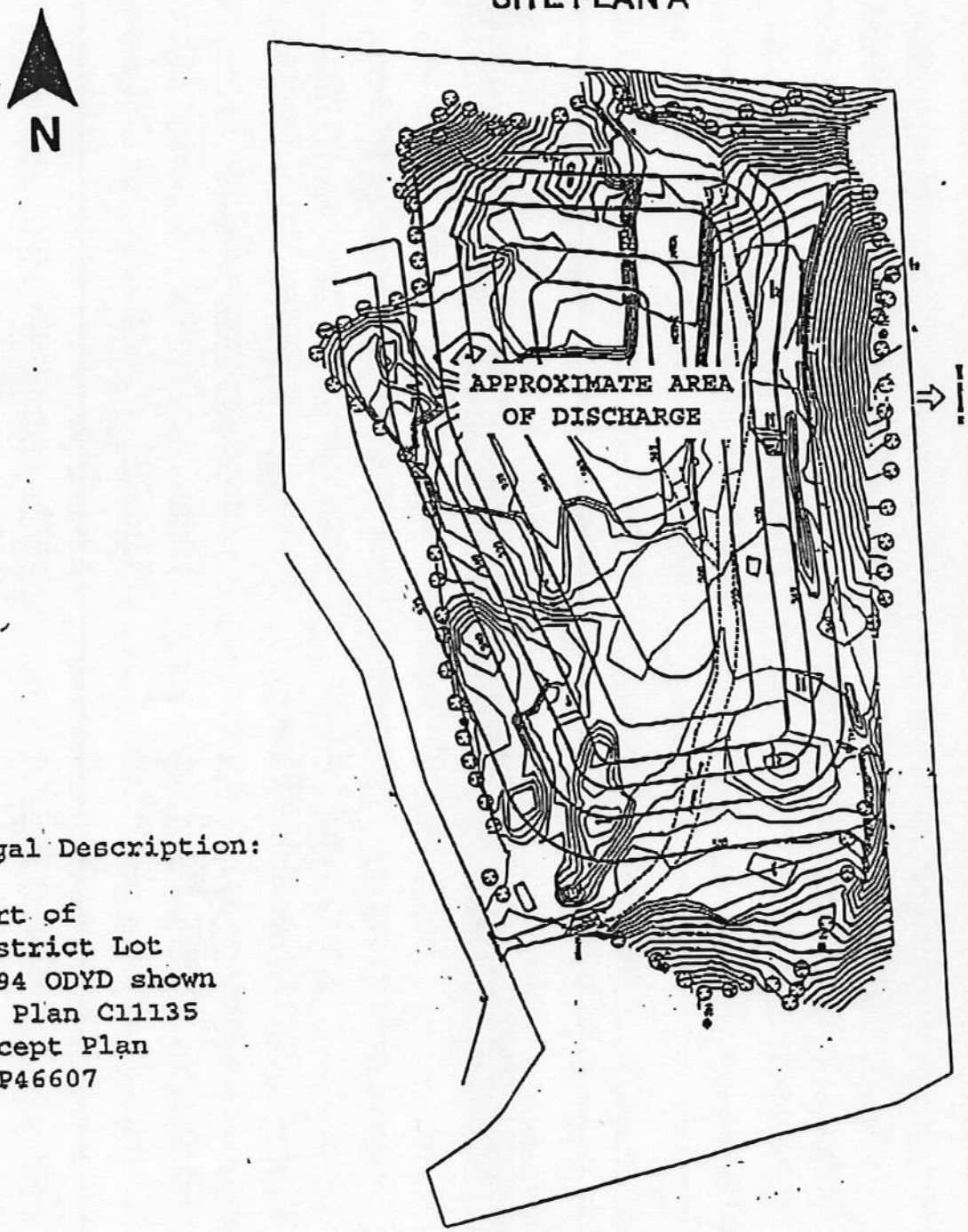
T.R. Forty, P.Eng.
Assistant Regional Waste Manager

3.13 Operation of Other Control Systems

Operation of other environmental control systems for leachate and run-off as well as monitoring of leachate, groundwater and surface water must be continued during the entire post-closure period unless the early suspension of such operations or monitoring is authorized by the Regional Waste Manager.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

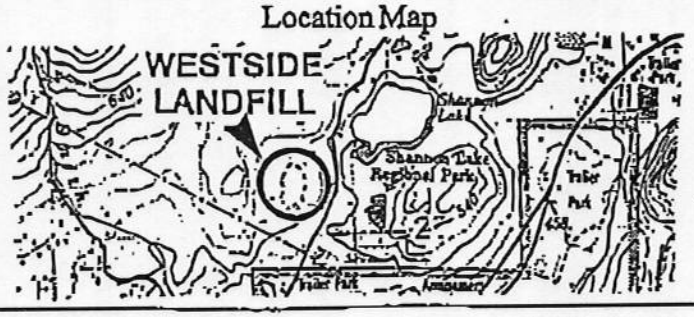
SITE PLAN A



Legal Description:

Part of
District Lot
3794 ODYD shown
on Plan C11135
Except Plan
KAP46607

Location Map



OPERATIONAL CERTIFICATE: PR-12217

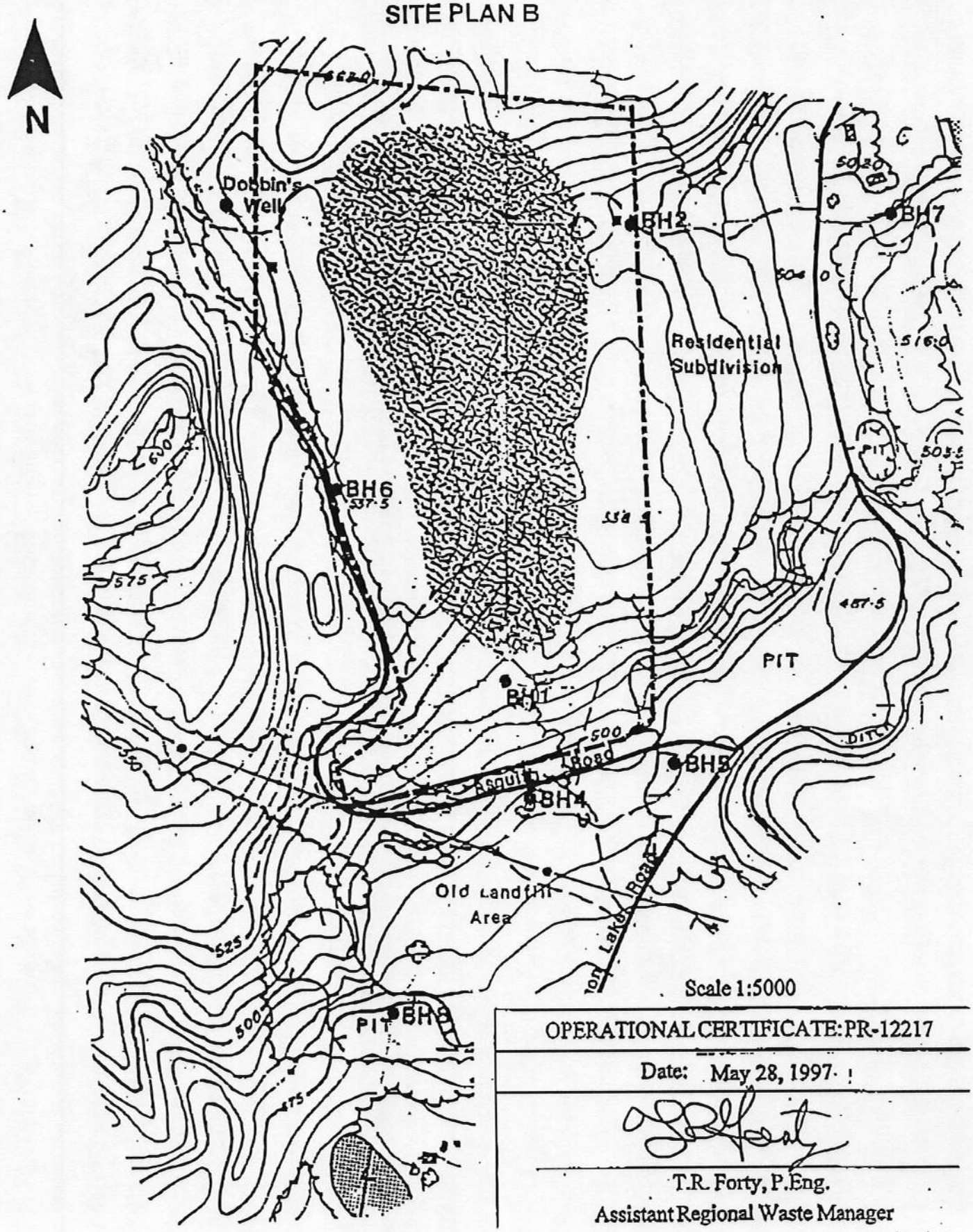
Date: May 28, 1997

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

PROVINCE OF
BRITISH COLUMBIA

Pollution Prevention

SITE PLAN B



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OPERATIONAL CERTIFICATE: PR-12217

Date: May 28, 1997

T.R. Forty, P.Eng.

Assistant Regional Waste Manager

September 6, 2017 Authorization Number: 12217

VIA EMAIL: clarke.kruiswyk@cord.bc.ca

Clarke Kruiswyk
Environmental Services Analyst
Regional District of Central Okanagan
1450 KLO Road, Kelowna, BC, V1W 3Z4

Dear Mr. Clarke Kruiswyk:

Re: *Environmental Management Act* approval of Closure Plan for Westside Landfill (Authorization 122217).

Thank you for your email dated March 10, 2016 and submission of the Westside Landfill Closure Plan dated May 12, 2015 by Golder Associates (Report Number 1406505-003-R-Rev0-5000) (the "Closure Plan"). Ministry review of the Closure Plan indicates that it conforms with current ministry policy (Landfill Criteria, 2nd Edition – 2016), and with respect to final cover, it meets the intent of clause 2.11 (Final Cover) of Operational Certificate (OC) 12217. As such, the Closure Plan is hereby approved in accordance with clause 2.4 of the OC, and the detailed final cover requirements included in clause 2.11 are replaced by those contained in the Closure Plan.

The Ministry further acknowledges that OC 12217 should now be updated to reflect the closed status of the site. The Regional District of Central Okanagan is requested to submit an application to amend the current OC to remove requirements that are no longer relevant, and instead incorporate requirements related to ongoing closure and post-closure activities. For reference, the 2016 Landfill Criteria describe the ministry's expectations pertaining to post closure operation and maintenance including but not limited to those in sections 7.4 (Post Closure Operation and Maintenance), 7.4 (Contaminating Lifespan), 9.0 (Monitorimng Criteria), and 10.3.4 (Closure Plan).

Application instructions and forms are available on the Ministry's website at: http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/guidance-forms-and-fees.

If you have any questions, please contact Roshan D'Souza, Environmental Protection Officer at 250 354 6365 or email Roshan.Dsouza@gov.bc.ca.

Yours truly,

Luc Lachance, P.Eng.
For Director,
Environmental Management Act

APPENDIX B

Updated Landfill Monitoring Program (Golder 2014) and MoE Approval Letter dated 26 July 2016

May 6, 2014

UPDATED LANDFILL MONITORING PROGRAM

Westside Landfill

Submitted to:
Regional District of Central Okanagan
1450 KLO Road
Kelowna, BC
V1W 3Z4

REPORT

Report Number: 041440062-002-R-Rev0-4001

Distribution:

2 copies - Regional District of Central Okanagan
2 copies - Ministry of Environment
2 copies - Golder Associates Ltd.

Golder Associates

Study Limitations

This report was prepared for the exclusive use of the Regional District of Central Okanagan (RDCO). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

The report, which includes all appendices and attachments, is based on data and information collected during the investigation conducted by Golder Associates Ltd.'s personnel and upon third party information provided by the RDCO. The report provides a level of assurance commensurate with the level of study.

Golder has relied in good faith on information provided to us. We accept no responsibility for any deficiency, misstatements or inaccuracies contained in this report as a result of omissions, misinterpretations of fraudulent acts of the persons or agencies interviewed.

This work was performed according to current professional standards and practices in the environmental field. If new information is discovered during future work, including excavations, borings or other activities or studies, Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

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APPENDICES

APPENDIX A
"Dobbin's Well" Log

1.0 INTRODUCTION

Westside Landfill (Figure 1), operated by the Regional District of Central Okanagan (RDCO) under Operational Certificate PR#12217, stopped receiving waste in July of 2010. A conceptual closure plan, *Closure Plan – Okanagan Falls Wood Waste Landfill* (CH2M HILL Canada Ltd. 2011) was developed, with additional options for the cover system being considered in *Options for Final Cover Systems, Westside Landfill* (Golder Associates Ltd. 2012). Additional planning, design and works related to closure are underway, along with continuing groundwater and landfill gas monitoring programs.

Golder prepared a landfill gas management plan (Golder Associates Ltd. 2013a), *Landfill Gas Management Plan, Westside Landfill*, hereafter referred to the as the LGMP, which began being implemented in May of 2013. Based on assessment of the results of the landfill gas monitoring over 2013 and experience with implementing the LGMP, Golder recommends some modifications to the LGMP, as outlined in Section 2.0 of this report.

Golder proposes some additional changes to other aspects of site monitoring, in part to reflect the fact that the site no longer receives waste and is in the process of being closed. Proposed modifications to the groundwater monitoring program are discussed in Section 0 of this report. In Section 0 of this report, Golder proposes surface water sampling on an interim basis, partly in response to an apparent increase in surface water ponding on the west side of the landfill observed in 2013. In Section 5.0 of the report, site inspection requirements are discussed and post-closure reporting requirements are discussed in Section 6.0. A summary of recommendations is provided in Section 7.0.

2.0 LANDFILL GAS MONITORING

The landfill gas monitoring program was modified in 2013 to begin implementing the approach outlined in the LGMP, and documented further in the report, *2012 Annual Operations and Monitoring Report, Westside Landfill, West Kelowna, BC* (Golder Associates Ltd. 2013b), hereafter referred to as the 2012 Annual Report. The key changes to the monitoring program were made to bring the landfill gas monitoring program into alignment with the recommendations outlined in the LGMP, as follows.

- The number of rounds of gas monitoring was increased to take place monthly from October to April inclusive, and once in either July or August.
- An “Action Plan” was developed that defined the response if methane readings above set thresholds were measured, with different actions being required depending on the proximity of the monitor to the property boundary. Some actions were to be completed within one week of a methane measurement being recorded, which meant that the process for recording and transmitting the readings to a qualified professional needed to be completed in much less than one week to allow appropriate responses to be implemented.

Most of the changes to bring the landfill gas monitoring program into alignment with the requirements of LGMP were implemented by the May 2013 monitoring round.

REFERENCE

IMAGE OBTAINED FROM GOOGLE EARTH PRO. USED UNDER LICENSE.
IMAGERY DATE: 2013. GOOGLE EARTH IMAGE IS NOT TO SCALE.

0 2,500 5,000
1:100,000 METRES

CLIENT
WESTSIDE LANDFILL

PROJECT
MONITORING PROGRAM REVISION
KELOWNA, BC

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-02-17
PREPARED	AMW
DESIGN	GB
REVIEW	GB
APPROVED	RP

TITLE
KEY PLAN

PROJECT No.	PHASE	Rev.	FIGURE
04-1440-062	4001	A	1

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

0 25 mm

Based on continuing assessment of the historical and recent (2013) landfill gas monitoring results, and on experience with implementation of most elements of the revised landfill gas monitoring program from May to December, Golder proposes some modifications to the LGMP. These proposed revisions are related to the following:

- schedule for monitoring rounds, based on review of results from 2013 and earlier;
- criteria for classification of monitors;
- the Action Plan; and
- the approach to data collection, review and reporting.

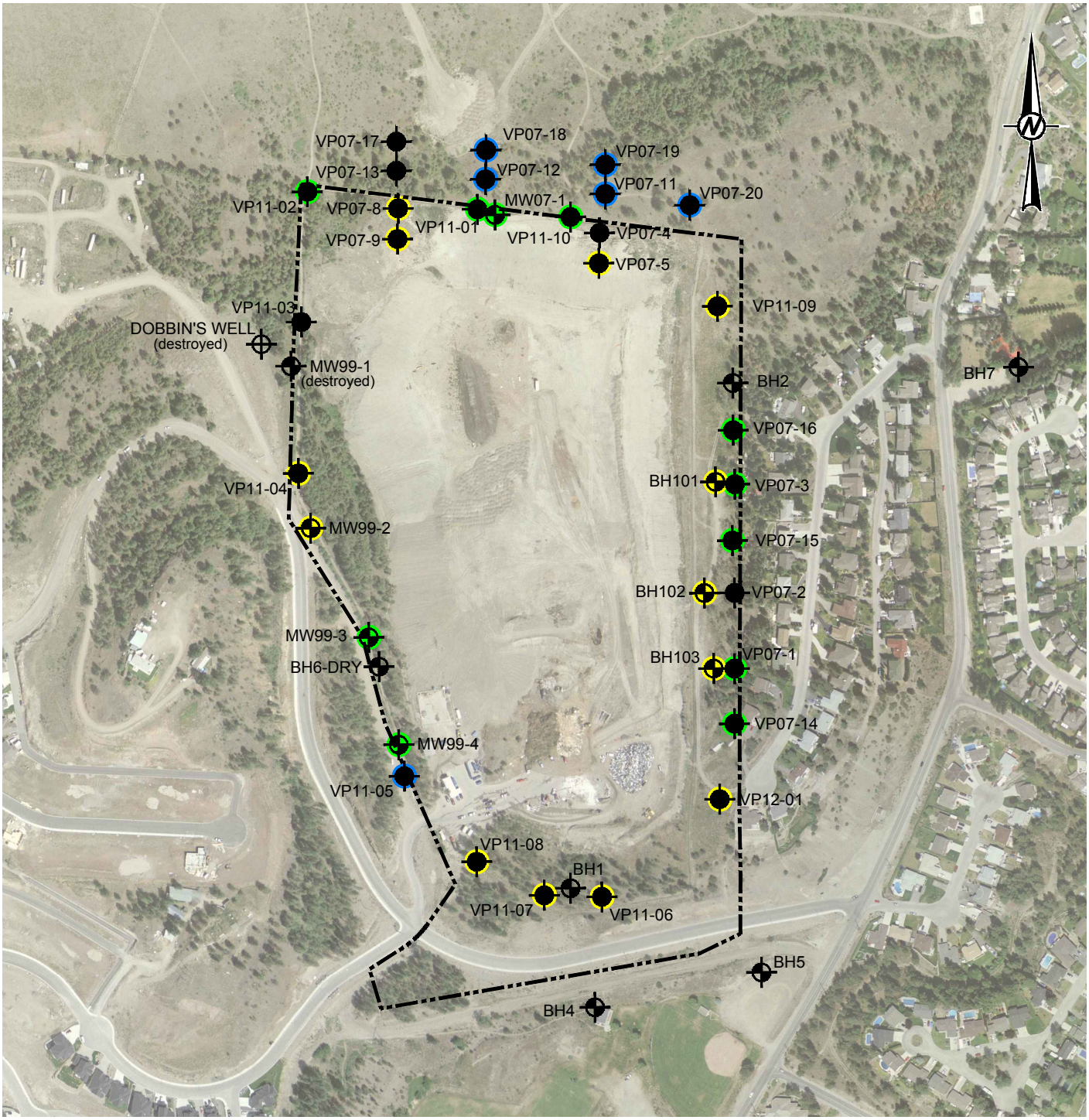
These proposed revisions are discussed in Sections 2.1 through to 2.4 of this report.

2.1 Proposed Changes in Landfill Gas Monitoring Schedule

The landfill gas monitoring schedule proposed in the LGMP was based in part on recommendations initially made in the *Westside Landfill Closure Plan, Final Report* (CH2M HILL Canada Ltd. 2011). The Closure Plan suggested quarterly monitoring, increased to monthly during the "winter" months. Climate data were reviewed in the LGMP, and winter was provisionally defined as the period from October to April, based mainly on monthly snowfall and data during "days <= 0C". An additional round of sampling would then take place in July or August. A preliminary assessment of historical methane measurements suggested that the proposed monitoring program would have "captured" the historical exceedances of the proposed action levels, although the number of data points was very limited for some months of year, and therefore the results were considered preliminary rather than definitive.

In consultation with the British Columbia Ministry of Environment (MoE), action levels were developed that varied by the location of the monitor with respect to the property boundary. As discussed further in Section 2.2, the monitors were classified as being "inside boundary", "near boundary" or "outside boundary" for the purpose of defining action levels. The locations of the landfill gas monitors and their original classification are illustrated in Figure 2. In the case of "near boundary" monitors and "outside boundary" monitors, actions were specified for methane levels that equalled or exceeded 10% LEL (lower explosive limit). For the "inside boundary" monitors the action level was 25% LEL.

Since completion of the LGMP, historical methane levels have been compiled and analyzed for results from 2000 to 2013. The data was compiled primarily from tables used in annual reports up to 2012, and after that directly from data collected in 2013. The data set may not include some methane results recorded for programs other than the monitoring program, and is not identical to the data set used for the preliminary assessment of results report in the LGMP; however, it does represent the largest set of landfill gas data yet analyzed for Westside Landfill.



LEGEND

- APPROX. LANDFILL BOUNDARY
- APPROX. MONITORING WELL LOCATION
- APPROX. SOIL VAPOUR WELL LOCATION (2007)
- ACTIVE OUTSIDE BOUNDARY MONITORS
- ACTIVE NEAR BOUNDARY MONITORS
- ACTIVE INNER BOUNDARY MONITORS

REFERENCE
ORTHOPHOTO OBTAINED FROM RDCO. IMAGERY DATE: 2009

0 100 200
1:5,000 METRES

CLIENT
WESTSIDE LANDFILL

PROJECT
MONITORING PROGRAM REVISION
KELOWNA, BC

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-02-17
PREPARED	AMW
DESIGN	GB
REVIEW	GB
APPROVED	RP

TITLE
MONITOR LOCATIONS AND ORIGINAL CLASSIFICATION

PROJECT No.	PHASE	Rev.	FIGURE
04-1440-062	4001	A	2

The percentage of methane readings that exceeded the 10% LEL action limit (the lowest limit that applies) is shown in Table 1 by month, along with the total number of measurements made in each month, and grouped by the side of the landfill that the measurements were associated with. To date, the only exceedances of the 10% LEL action limit have been on either the east or north side of the landfill, with most being associated with monitors on the east side. The cells' shading varies with the % LEL to make patterns easier to visualize.

Table 1: Summary of the Percentage of Methane Readings that Exceed the 10% LEL Action Limit

	Fall			Winter			Spring			Summer		
Side	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
East	0%	0%	9%	9%	0%	6%	12%	6%	6%	0%	0%	0%
North	0%	0%	0%	0%	0%	0%	6%	6%	0%	0%	0%	0%
South	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
West	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cover MC*	0%	0%	25%	36%	44%	61%	100%	75%	21%	0%	0%	0%
Sample Size	**33**	**65**	**31**	**210**	**42**	**13**	**33**	**32**	**173**	**42**	**32**	**32**

**MC = predicted moisture content, as a percent of the maximum water holding capacity*

All of the exceedances of 10% LEL in Table 1 were recorded in the period from November to May, with the highest frequency of readings exceeding 10% LEL being in March.

Water balance modelling completed for assessment of cover options (Golder Associates Ltd. 2012) suggested that the peak water content would typically be expected in March. While the cover system is not completed, much of the landfill already has cover that is close to that required for final closure and therefore it is anticipated that the water balance for the existing cover will approximate that of the modelled moisture content for much of the landfill. The predicted moisture content for the cover system is included in Table 1 by month, for a "normal" year. Cell shading by value has been used to make variations in moisture content easier to visualize.

As can be seen from the results presented in Table 1, the percentage of values of methane that exceed the 10% LEL level show an apparent correlation with the predicted water content of the cover soils. There is potentially a causal link between water content and methane levels in the subsurface. As the water content of soil increases, the gas permeability will decrease, becoming very low as the water content approaches and reaches saturation (100% water content). Thus, as the water content of surface soils increases, venting through the landfill cover is expected to be impeded; this may account for the apparent correspondence between the expected water content of the cover soil and the frequency that a reading of 10% LEL was exceeded.

As can also be seen from the results in Table 1, methane levels exceeding 10% LEL were only observed on the east and north sides of the landfill. In fact, exceedances of 10% LEL have only been recorded at five of the existing monitors, including BH-1, BH102, BH103, VP07-11 and VP11-09. The methane results for these five monitors are summarized in Table 2. Note that with over 684 measurements of methane in the remaining

monitors, no exceedances of a 10% LEL have been recorded. The one exceedance for BH-1 was recorded in 2004, and there were no further exceedances to the end of monitoring in 2010. Two landfill gas monitors, VP11-06 and VP11-07, were established in the immediate vicinity of BH-1 and replace it in the monitoring system. Another monitor, VP11-08, is also located on the south side of the landfill and provides additional coverage of this portion of the landfill (see Figure 2).

Table 2: Summary of Exceedances, by Monitor

Monitor	>10% LEL	>25% LEL	>100% LEL	Total
Number of exceedances of specified % LEL levels				
BH 102	11	7	6	36
BH 103	2	0	0	36
VP07-11	2	1	0	12
BH-1	1	1	1	24
VP11-09	1	0	0	12

No readings from any monitor have exceeded 10%LEL in the period from June to October (Table 1). Golder recommends that a full round be collected in August and that partial rounds be completed in June, July, September and October, on an interim basis. The partial rounds would include the four monitors in the existing program where exceedances have been recorded, including BH102, BH103, VP07-11 and VP11-09. The three monitors closest to BH-1 (VP11-06, VP11-07 and VP11-08) would also be included in the partial rounds. If exceedances of actions levels are noted, additional measurements might be required at other monitors, including VP07-1, VP07-2 and VP07-19, following the protocol that will be described in Section 2.4.

The proposed change to landfill gas monitoring outlined above would be an interim measure, with further revision likely after the results from 2014 have been assessed and additional work is completed to further assess options for landfill gas migration control.

2.2 Proposed Revisions to the Classification of Monitors

In the LGMP, three classes of monitor were defined:

- inside boundary monitors – these are monitors located more than 5 metres (m) from a property and had an associated action threshold for methane of 25% LEL;
- near boundary monitors – these are monitors located inside the landfill property, but located 5 m or less from the property boundary and had an associated action threshold for methane of 10% LEL; and
- outside boundary monitors – these are monitors located outside the boundary and no specific action thresholds were defined for these monitors, but provisionally the action limit has been set as being the same as that for the near boundary monitors (10% LEL) and the actions are similar.

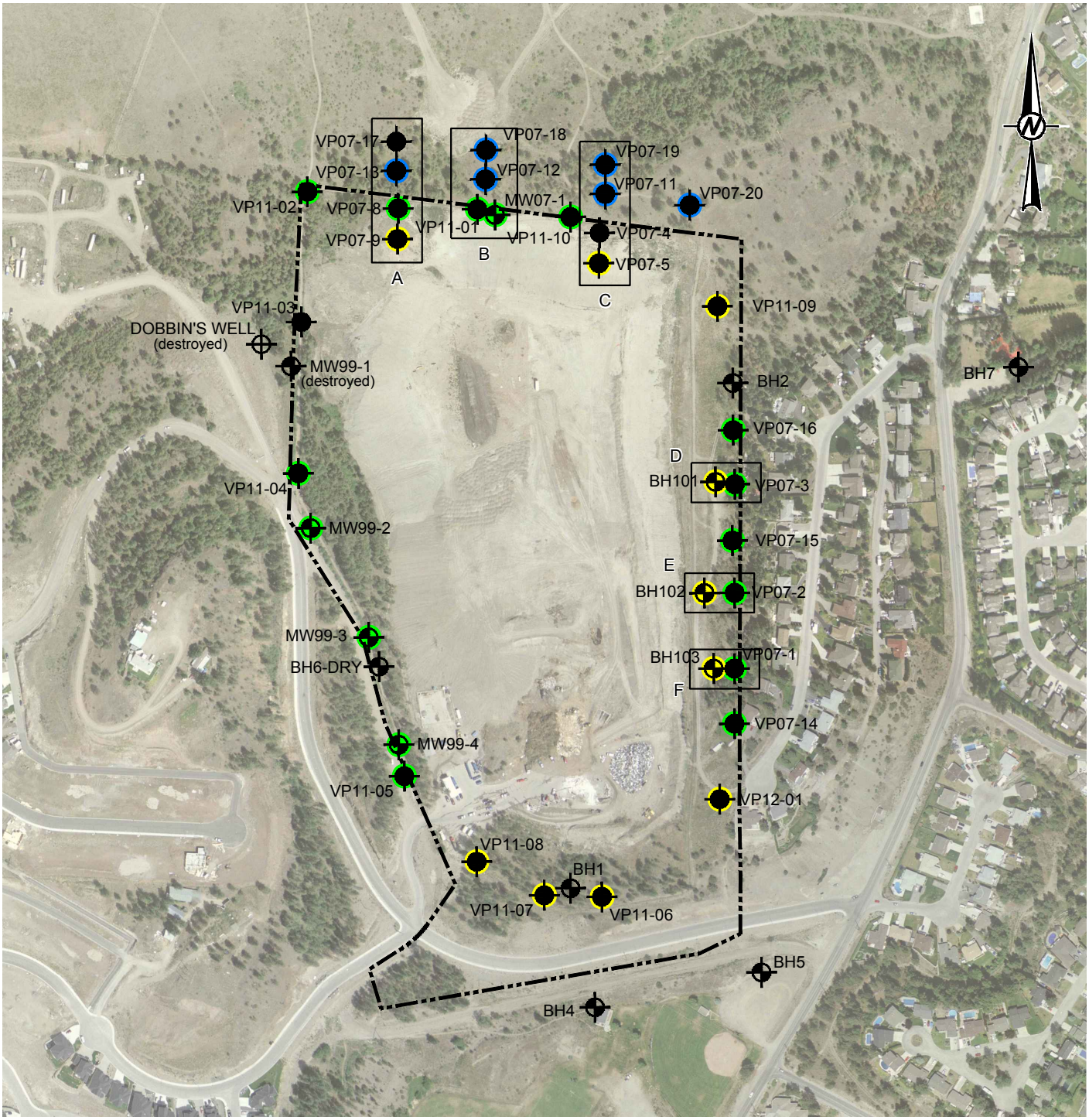
As can be seen in Figure 2, there are a number of monitors that are fairly close to the property line, but classified as being “inside” and “outside” monitors because they are just outside the 5 m limit set in LGMP. Golder recommends modifying the definitions of monitors by position such that “inside boundary” monitors are those monitors located within the landfill boundary and more than 15 m inside that property boundary. “Near boundary” monitors would comprise those monitors within 15 m of the property boundary, and “outside boundary” monitors would comprise those located more than 15 m outside the property boundary. This change results in lowering the action threshold for some monitors from 25% LEL to 10% LEL. The change does not lead to an increase in the action threshold for any monitor. The proposed change is consistent with provisions of the original Action Plan that indicate that actions should be taken to determine the geographic extent of methane levels that are greater than 10% LEL (as will be discussed further in Section 2.3).

In the Action Plan outlined in the LGMP, if a monitor exceeds the associated action level, then a series of actions are triggered that may include assessing the levels in a “step-out” monitor, if one exists, or establishing such a monitor if one does not exist. A “step-out” monitor is a monitor that is located further from the landfill than another monitor on a line extending at right angles (approximately) to the property boundary. There are a number of monitors where associated “step-out” monitors are already in place. Under the existing Action Plan, no additional actions are required if the outermost “step-out” monitor in a set is under the appropriate criteria for that monitor. There are six such sets of monitors; sets A to F, as illustrated in Figure 3. A “step-out” monitor exists for every currently active monitor that has exceeded an associated action level specified in the current LGMP.

As can be seen in Figure 3, there are some “near boundary” and “outside boundary” monitors that have no associated “step-out” monitors. The associated action level for “near boundary” monitors is 10% LEL and this has been held to apply for the “outside boundary” monitors as well. There are several “inside boundary” monitoring wells that do not do not have associated “step-out” monitors, including VP11-07, VP11-08, VP11-09 and VP12-01. Since these are “inside boundary” monitors, under the current LGMP the action level would be 25% LEL. However, since there are no associated “step-out” monitors, adopting an action level of 10% LEL is recommended for these monitors unless a new “step-out” monitor is installed. Essentially, an overarching “rule” is being applied: if there are no monitors further from the centre of the landfill approximately in line with a given monitor, then the action level for that monitor is 10% LEL, irrespective of position relative to the landfill boundary. If there are associated step-out monitors, then the action level is set at 10% LEL for all near and outside boundary monitors, and at 25% LEL for inside monitors. This rule is illustrated in Figure 4.

As noted, under the proposed new rule the action level for several monitors would change from 25% LEL to 10% LEL, including VP11-09, which is significant since the highest methane level recorded for this monitor in 2013 was equivalent to 20.5% LEL in March of 2013. A reading of 20.5% LEL is under the action level currently outlined in the LGMP for this monitor because it is an “inside boundary” monitor, but would exceed the proposed 10% LEL limit recommended because there is currently no associated “step-out” monitor. Thus, an additional step-out monitor that would be associated with VP11-09 might be required if the proposed modification to the LGMP is adopted and if the 10% LEL is exceeded again. However, it should be noted that since starting implementation of the LGMP in May 2013, the highest methane level recorded at VP11-09 was only 1.1% LEL.

Golder envisions that post-closure monitoring requirements may change significantly after closure works are completed, depending in part on future results and upon the nature of any landfill gas control works implemented. The monitoring program will continue to be evaluated as new information is gathered, and recommendations for modifications, if any, will be part of the annual landfill reports.



LEGEND

- APPROX. LANDFILL BOUNDARY
- APPROX. MONITORING WELL LOCATION
- APPROX. SOIL VAPOUR WELL LOCATION (2007)
- A — MONITOR SETS
- ACTIVE OUTSIDE BOUNDARY MONITORS
- ACTIVE NEAR BOUNDARY MONITORS
- ACTIVE INNER BOUNDARY MONITORS

REFERENCE
ORTHOPHOTO OBTAINED FROM RDCO. IMAGERY DATE: 2009

0 100 200
1:5,000 METRES

CLIENT
WESTSIDE LANDFILL

PROJECT
MONITORING PROGRAM REVISION
KELOWNA, BC

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-02-17
PREPARED	AMW
DESIGN	GB
REVIEW	GB
APPROVED	RP

TITLE
MONITOR LOCATIONS AND REVISED CLASSIFICATION

PROJECT No.	PHASE	Rev.	FIGURE
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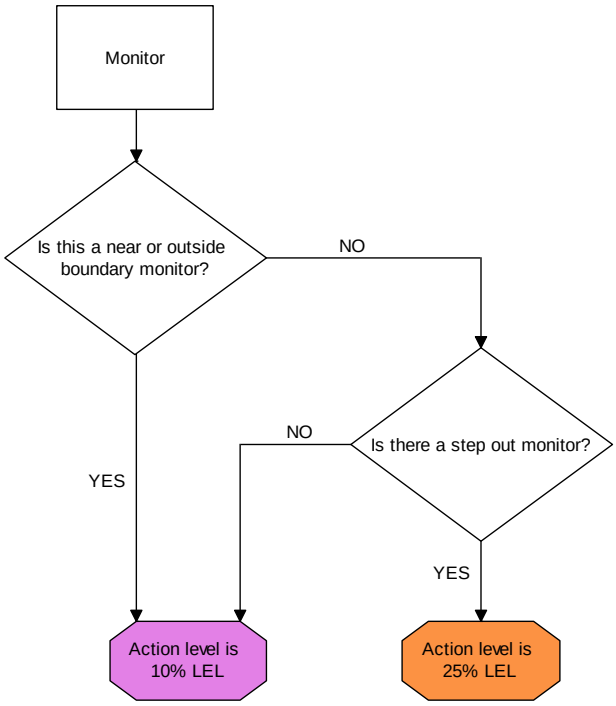

All monitors have an associated action level of 10% LEL except for inside bounary monitors with an associated step-out monitor, which have an action level of 25%.

CLIENT
REGIONAL DISTRICT OF CENTRAL OKANAGAN

PROJECT
MONITORING PROGRAM REVISION
WESTSIDE LANDFILL

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-02-17
PREPARED	GB
DESIGN	GB
REVIEW	RP
APPROVED	RP

TITLE
ESTABLISHING ACTION LEVELS

PROJECT No	PHASE	Rev	FIGURE
04-1440-062	4001	0	4

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25 mm

2.3 Revision to Data Collection Procedure

The methods of data collection were reviewed after completion of the LGMP and modified to allow results to be assessed more quickly. Data is still recorded manually on paper forms, but a digital collection system that can be used on "smartphones" was implemented. Data is recorded in the field and sent from the field to a qualified professional, who can then compare the results against action levels, and then implement the Action Plan, which may involve notification of the MoE and development of a detailed plan by a qualified professional, in consultation with the RDCO and MoE.

2.4 Proposed Revision to the Action Plan

As discussed in Section 2.2, Golder has proposed that action levels for monitors be set following the procedure summarized in the flow chart presented in Figure 4, and the action levels for each of the current monitors is summarized in Figure 5. In the LGMP, the first step to take if a methane level above the action level was to recalibrate instruments and retest within a week. However, as discussed in Section 2.3, with changes in how quickly field data can be assessed and how quickly possible calibration issues can be assessed, the revised procedure assumes that recalibration and repeating the measurements will take place within 24 hours rather than within one week, and thus is now considered a step completed as an integral part of the sampling round rather than as part of a follow-up round. Given that "step-out" monitors have already been established for most of the monitors that have historically exhibited methane levels above their associated action level, the next action is to determine the levels in the "step-out" monitors. If the methane levels in the "step-out" monitor furthest from the landfill are less than 10% LEL, then under the LGMP no further action is required. The proposed revised methane Action Plan is summarized in the flow chart presented in Figure 6.

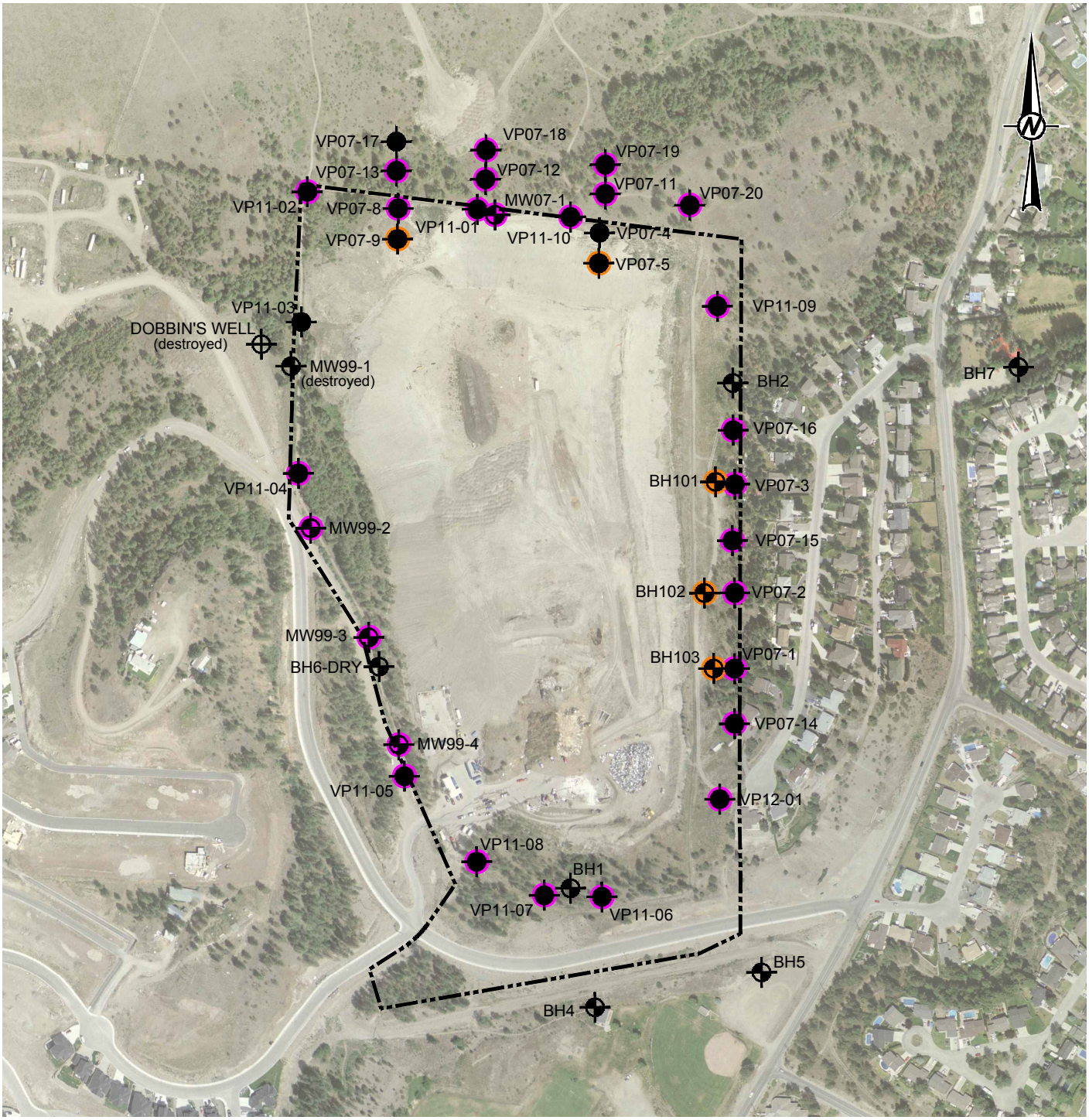
3.0 GROUNDWATER MONITORING

Groundwater monitoring is currently conducted quarterly at five “down-gradient” locations: BH-1, BH-2, BH-3, BH-4, BH-5, and BH-7 (see Figure 7). Water samples are tested for a defined set of parameters and water level measurements are also recorded. The results of analyses to 2005 for a residential well that no longer exists, generally referred to as “Dobbin’s Well”, was located on the “upgradient” side of the landfill, were sometimes used to represent possible background groundwater conditions. At present there are no “background” monitors being sampled.

Golder proposes some changes to the groundwater monitoring program with respect to monitoring background conditions, the frequency of sampling and analysis and the frequency of groundwater level measurements.

3.1 Background Monitoring

Dobbin’s Well was completed to a depth of 180 feet, or just less than 55 m. This is considerably deeper than the groundwater monitors, which range from less than 1 m in depth to just over 17 m in depth. The monitors closest to Dobbin’s Well – MW99-1, MW99-2, MW99-3 and MW99-4 – varied between 6 and 7 m deep, and extended to about 1 to 2.5 m into bedrock. Dobbin’s Well extended through about 1.2 m of “soft bedrock” and was drilled another 44.5 m into “bedrock” according to the well log (see Appendix A). It is quite likely that Dobbin’s Well is associated with a deeper bedrock aquifer rather than the groundwater monitors currently in use (Golder Associates Ltd. 2014). While Dobbin’s Well may be upgradient of the site, it is not necessarily completely representative of the near surface groundwater quality upgradient from the landfill.



LEGEND

- APPROX. LANDFILL BOUNDARY
- APPROX. MONITORING WELL LOCATION
- APPROX. SOIL VAPOUR WELL LOCATION (2007)
- MONITORS WITH ACTION LEVEL OF 25% LEL
- MONITORS WITH ACTION LEVEL OF 10% LEL

REFERENCE
ORTHOPHOTO OBTAINED FROM RDCO. IMAGERY DATE: 2009

0 100 200
1:5,000 METRES

CLIENT
WESTSIDE LANDFILL

PROJECT
MONITORING PROGRAM REVISION
KELOWNA, BC

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-02-17
PREPARED	AMW
DESIGN	GB
REVIEW	GB
APPROVED	RP

TITLE
CURRENT VAPOUR MONITOR ACTION LEVELS

PROJECT No.	PHASE	Rev.	FIGURE
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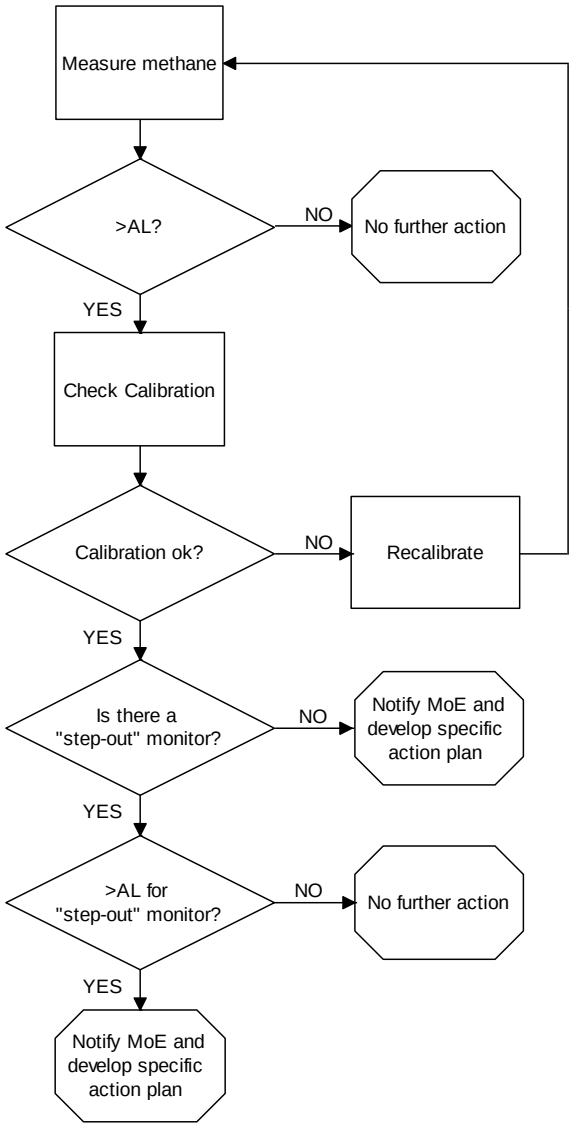


Notes: AL = Action Level

CLIENT
REGIONAL DISTRICT OF CENTRAL OKANAGAN

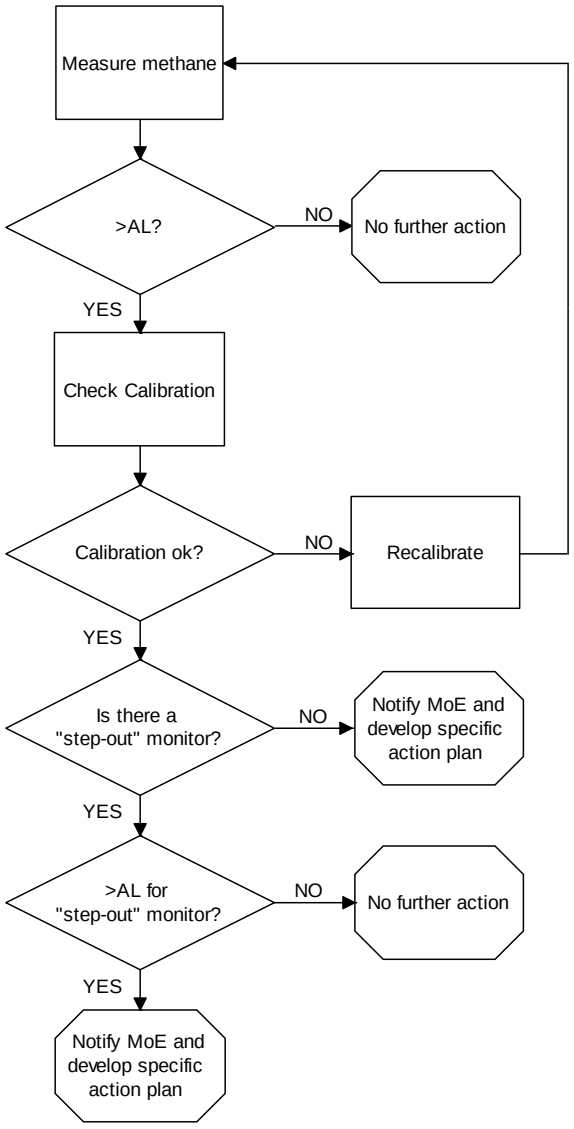
PROJECT
MONITORING PROGRAM REVISION
WESTSIDE LANDFILL

CONSULTANT

YYYY-MM-DD	2014-02-17
PREPARED	GB
DESIGN	GB
REVIEW	RP
APPROVED	RP

TITLE
METHANE ACTION PLAN

PROJECT No	PHASE	Rev	FIGURE
04-1440-062	4001	0	6



Notes: AL = Action Level

CLIENT
REGIONAL DISTRICT OF CENTRAL OKANAGAN

PROJECT
MONITORING PROGRAM REVISION
WESTSIDE LANDFILL

CONSULTANT

YYYY-MM-DD	2014-02-17
PREPARED	GB
DESIGN	GB
REVIEW	RP
APPROVED	RP

TITLE
METHANE ACTION PLAN

PROJECT No	PHASE	Rev	FIGURE
04-1440-062	4001	0	6

LEGEND

- APPROX. LANDFILL BOUNDARY
- APPROX. MONITORING WELL LOCATION
- APPROX. DOMESTIC WATER WELL LOCATION
- WATER LEVELS ONLY
- WATER QUALITY AND WATER LEVELS

REFERENCE
ORTHOPHOTO OBTAINED FROM RDCO. IMAGERY DATE: 2009

0 100 200
1:5,000 METRES

CLIENT
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KELOWNA, BC

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-02-17
PREPARED	AMW
DESIGN	GB
REVIEW	GB
APPROVED	RP

TITLE
GROUNDWATER MONITORS

PROJECT No.	PHASE	Rev.	FIGURE
04-1440-062	4001	A	7

While leachate may impact the balance of the major cations and anions somewhat, there should be some correspondence in both the concentration of the major cations and anions and their relative amounts. The relatives abundance of the major cations (Ca – calcium, Mg – magnesium, Na – sodium and K – potassium) and anions (total alkalinity as $CaCO_3$, SO_4 – sulphate and Cl – chloride) for the period of record are presented in Figure 8 for the existing monitors and for Dobbin's Well and MW99-2, a monitor that exists on site but is not currently part of the groundwater monitoring program.

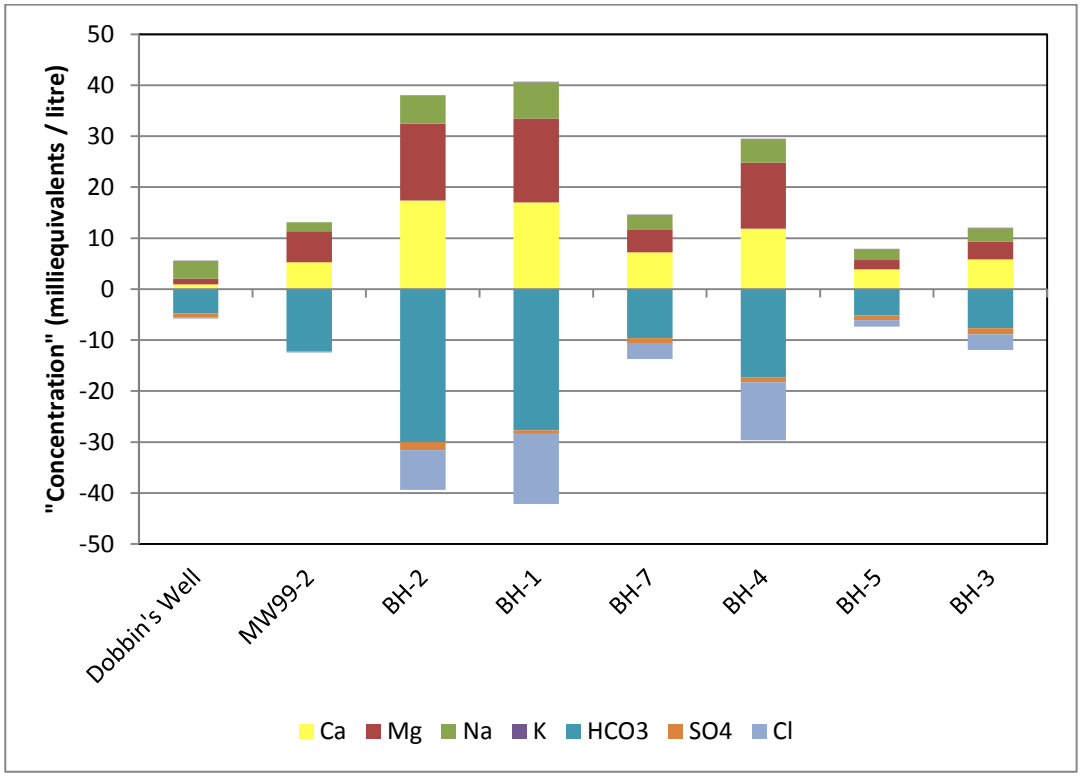

Figure 8: Relative Abundance of Major Ions, by Monitor

Both the relative and absolute abundance of the major cations and anions are quite different in Dobbin's Well, compared with the other monitors. In Dobbin's Well, sodium is the most abundant major cation (more so than calcium and magnesium combined), whereas in the other monitors the relative abundance of calcium and magnesium cations is greater than sodium. MW99-2 is located upgradient of landfill, but at shallower depth than Dobbin's Well. The results presented in Figure 8 suggest that MW99-2 is more similar in composition to the other monitors and since it appears to tap a shallower flow zone similar to that tapped by the other monitors, and thus may be more suitable as a background monitor than Dobbin's Well. Golder recommends including this monitor in the sampling rounds again.

3.2 Monitoring Frequency

As noted, monitoring currently takes place on a quarterly basis. Since the landfill no longer receives waste, has interim cover in place, and construction of a final cover system is underway, the risk that something will be introduced into the landfill that results in a sudden change in leachate generation and thus produce a "spike" in values is expected to be lower than it might be when the landfill was actively in operation. However, it is still necessary to assess trends over time. The key issue is whether such trends can reasonably be assessed with less than quarterly monitoring.

Golder has completed a limited analysis of historical data for selected parameters for the monitors currently included in the monitoring program. As discussed in *2013 Annual Operations and Monitoring Report* (Golder Associates Ltd. 2014), chloride, ammonia, nitrate, iron and manganese are considered as key indicators of "possible" impacts on groundwater quality. They are described as indicators of "possible" impacts since there are factors other than leachate that can influence the concentration of each one of these. Perusal of the results to date that for most of the key indicators suggested that where there are temporal trends, the variation within years appears, qualitatively at least, to be limited relative to the longer term trends.

Golder recommends that the MoE consider a phased reduction in groundwater monitoring. The first phase would involve moving to two rounds per year until the current landfill works are completed. At some point after closure works are completed, the matter would be revisited to consider reducing to annual monitoring, assuming the results support such a change, and continuing until such time as the results warrant considering removing groundwater monitoring requirements.

If the monitoring frequency is reduced to twice per year, Golder suggests that the rounds be spaced approximately six months apart, with sampling either in Q1 and Q3, or in Q2 and Q4. Golder reviewed historical data to determine if one of these possibilities should be preferred to the other. To gain more insight into this issue, the correlation between the readings in a given quarter and the average of the results for the other three quarters was estimated for selected parameters for results from each of BH-1, BH-2, BH-4, and BH-5. There were too few results for BH-2 and BH-7 to include them in this analysis. The parameters used for this analysis were chloride and manganese, two of the key parameters discussed in detail in the *2013 Annual Operations and Monitoring Report*. The other key parameters – ammonia, nitrate and iron – were excluded since for some monitors at least there were a significant number of results below the detection limit, which compromises the estimation of a correlation coefficient. Only years with results from all four quarters were included in the analysis (four to six years of data, depending on the monitor). The results are summarized in Table 3, below.

Table 3: Correlation of Average in Quarter to Average for Remaining Quarters for Selected Parameters

Period	Q1	Q2	Q3	Q4
Chloride				
BH-1	**0.49**	0.28	0.13	0.46
BH-2	0.88	**0.98**	0.93	0.95
BH-4	0.53	**0.86**	0.78	0.16
BH-5	0.92	**0.98**	0.97	0.81
Top Ranked	1	**3**	0	0
Average	*0.70*	***0.77***	*0.70*	*0.59*
Manganese				
BH-1	0.94	0.88	**0.96**	0.83
BH-2	0.36	**0.74**	0.21	-0.58
BH-4	0.25	**0.91**	0.37	0.88
BH-5	-0.38	0.57	**1.00**	-0.47
Top Ranked	0	2	2	0
Average	*0.29*	***0.78***	*0.63*	*0.17*

As summarized in Table 3, the results from Q2 show the highest correlation with the average for the remaining three quarters. The data analyzed is limited, and therefore the results are not definitive, but the results suggest that Q2 would be the best time to sample if monitoring eventually reduces to annual sampling. On this basis, it is recommended that Q2 be one of the quarters in which sampling takes place if the frequency is reduced to twice per year, which implies sampling in Q2 and Q4. Thus, for a phased reduction the sequence would be sampling and analysis in Q2 and Q4, followed by sampling in Q2 only at some point after closure works are completed, if continuing results suggest that is reasonable.

In Figures 9 through 13, the time series for the annual average value of chloride, ammonia, nitrate, iron and manganese are shown along with the time series for the average of Q2 and Q4 values. For some years, there is not data for all four quarters, or not all four sets collected in the year are in separate quarters (for example, there may be two rounds within a quarter if there are delays due to weather or other issues), hence Figures 9 through 13 do not perfectly represent how well the average for Q2 and Q4 tracks the annual average, but the results suggest that long-term trends in these parameters would be captured reasonably well by a monitoring program that consists of two rounds per year, in Q2 and Q4 of each year.

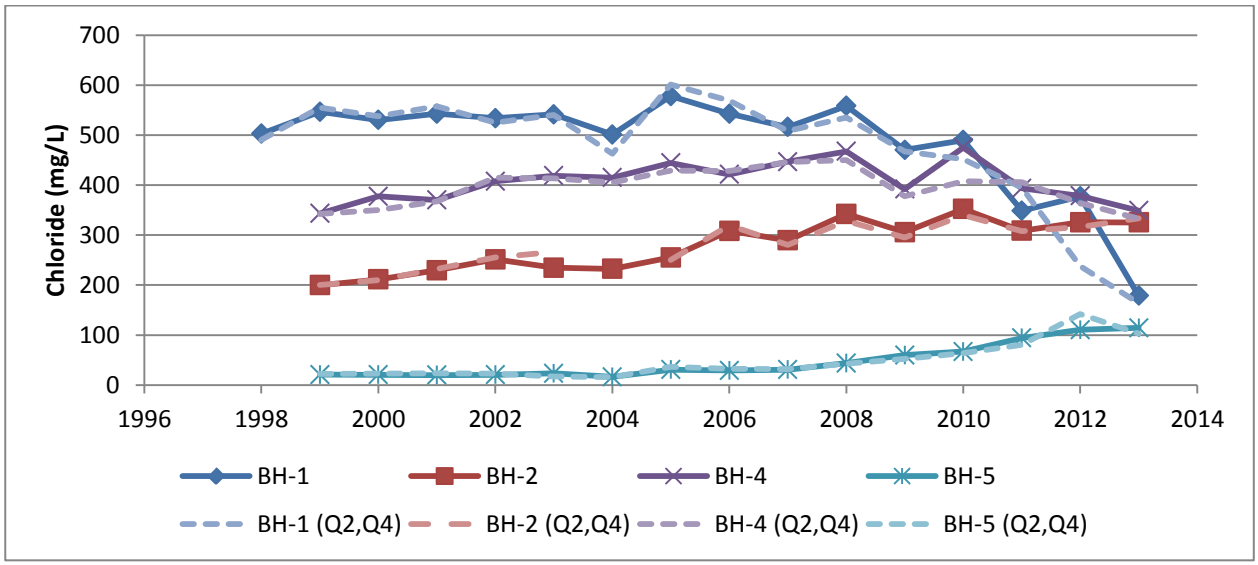

Figure 9: Chloride - Average Concentration based on Annual and Q2 plus Q4 results

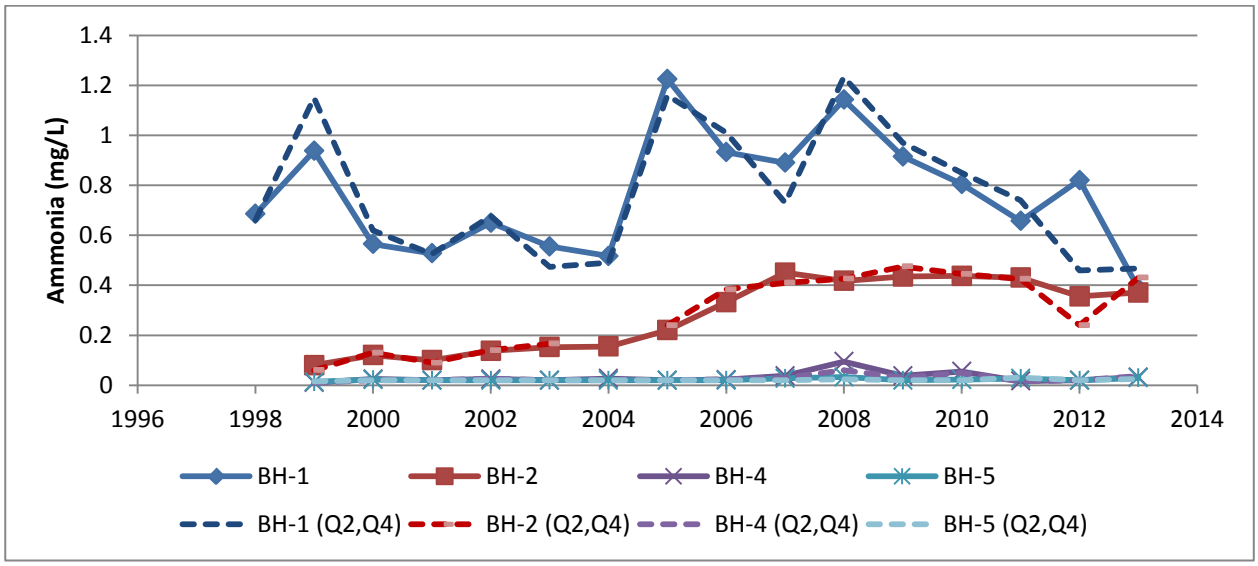

Figure 10: Ammonia - Average Concentration based on Annual and Q2 plus Q4 results

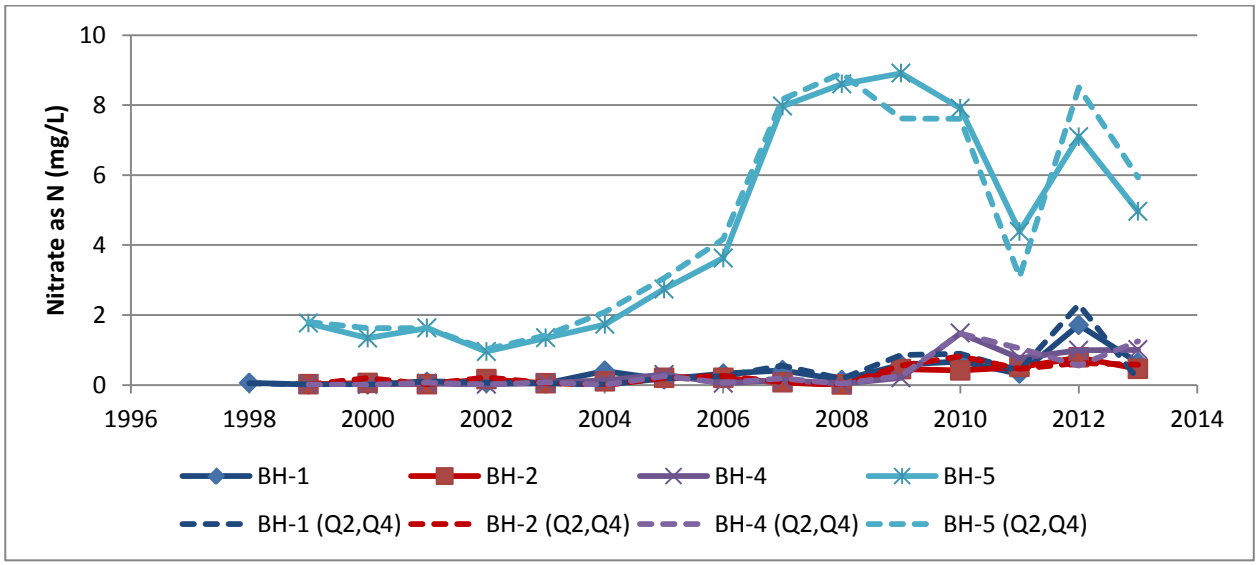

Figure 11: Nitrate as N - Average Concentration based on Annual and Q2 plus Q4 results

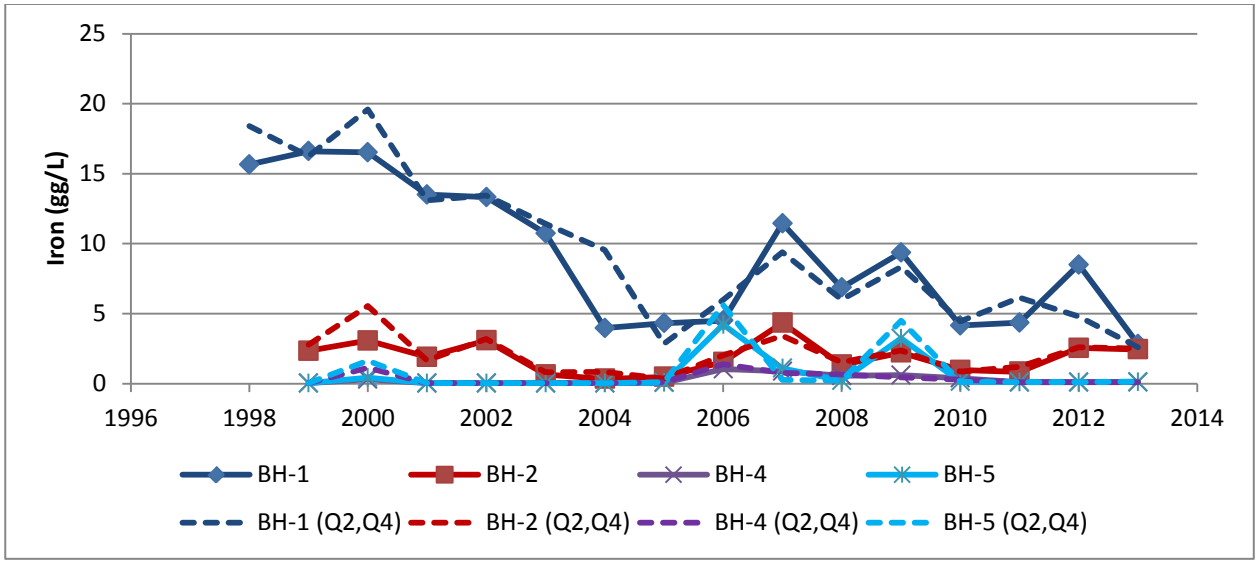

Figure 12: Iron - Average Concentration based on Annual and Q2 plus Q4 results

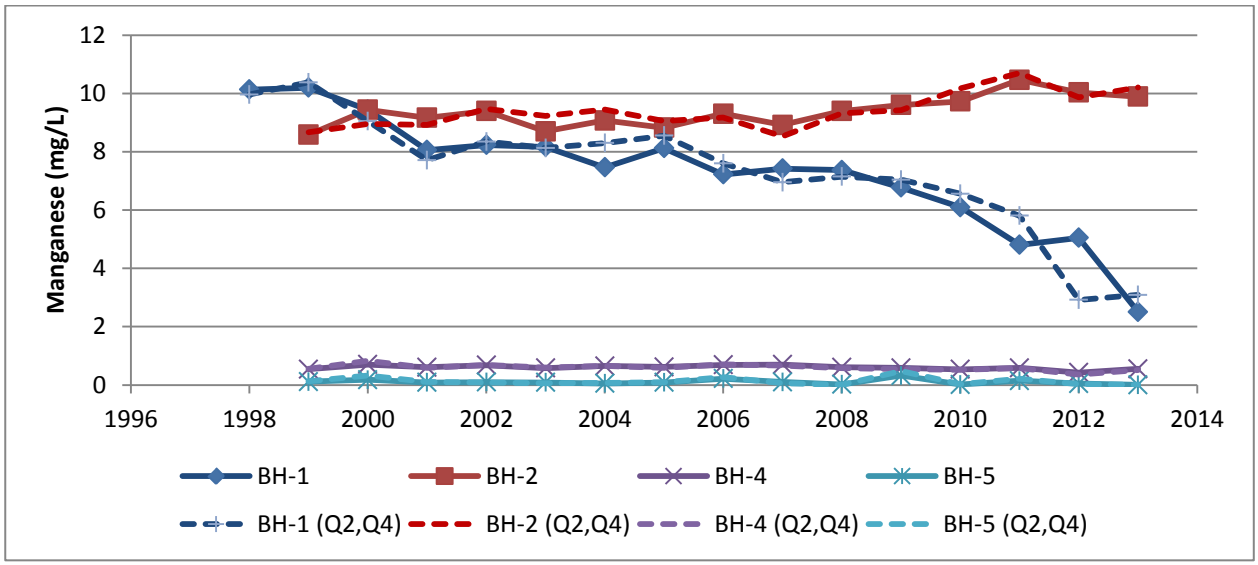

Figure 13: Manganese - Average Concentration based on Annual and Q2 plus Q4 results

3.3 Water Level Measurements

Water level measurements are currently taken at the monitors that are part of the current sampling and analysis program (BH-1, BH-2, BH-3, BH-4, BH-5 and BH-6) and from some monitors (MW99-2, MW99-3 and MW99-4) that were formerly sampled (Figure 7). The water level data from the MW99 series of wells has been recently used in assessing causes of the apparent increase of surface water ponding on the west side of the landfill, as will be discussed further in Section 0. Golder suggests that monitoring water levels in the MW99 series wells be continued in 2014 and then re-evaluated. The water levels would be determined at the same time as the proposed sampling rounds.

4.0 SURFACE WATER MONITORING

Surface water ponding on the west side of the landfill was noted early in 2013. Some surface water ponds had been observed to be present in this area previously, but the amount of ponding in 2013 was greater than what had been observed in recent years. Since there have been some changes in land use to the west, there was at least the possibility that the apparent increase in surface water ponding was related to these changes. Golder began monitoring the pond levels and also estimated seepages discharge rates to provide baseline measurements; see the 2013 Annual Report for additional discussion (Golder Associates Ltd. 2014).

Monthly climate data for Environment Canada's Kelowna MSWO site was compiled for the period 1998 to 2013. As can be seen from Figure 14, precipitation in both 2012 and 2013 was over 20% greater than the average for the period, and was higher than for any year since 2004. Thus increased recharge, resulting in increased water table elevations may be a contributing factor. Observations on site and reference to exiting mapping suggest that, although precise measurements are not available, there was an excavation at some point in the vicinity of these ponds that may result in the ponds being deeper and more extensive than they would have been prior to the excavation. The date of excavations is not known, but it is expected that they were completed at some point prior to end of filling in 2010.

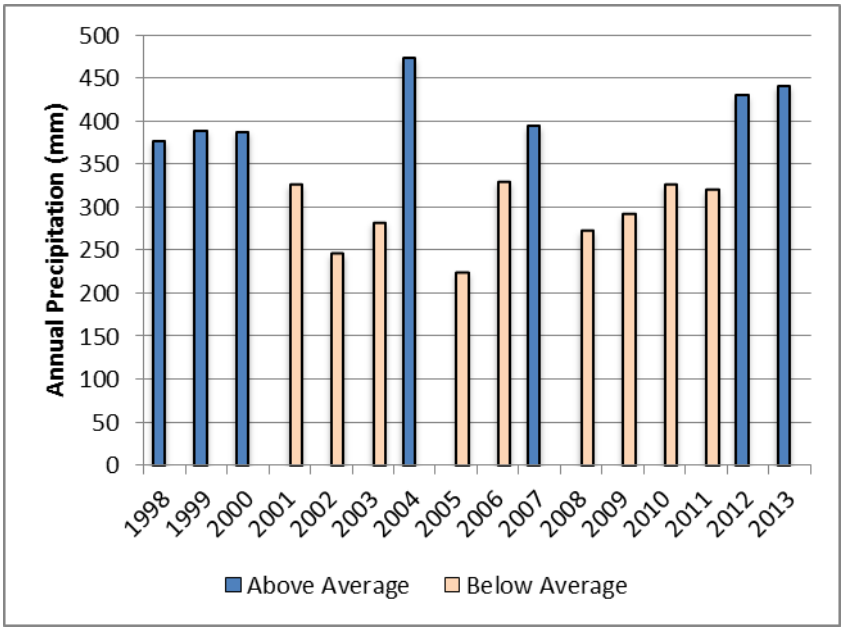

Figure 14: Annual Precipitation, Kelowna, 1996 to 2013

Golder recommends that water level elevations for the ponds continue to be completed with each groundwater monitoring event, but if observations during landfill gas monitoring rounds suggest that there have been significant changes in surface water levels, then groundwater level measurements should be completed. Golder also recommends that the elevations of local benchmarks for pond level measurements be determined as part of future survey work that is expected to be completed in 2014.

5.0 SITE INSPECTION

Operational Certificate PR12217 (Section 3.4) includes the requirement that vegetation be inspected at least once per year during the growing season to determine if environmental impacts are occurring. Golder recommends that a site walkover be completed annually, focusing in particular on identifying areas of surface erosion, differential settlement and the "health" of vegetation. It is recommended that the inspection be completed in the period from April to October to satisfy the requirement that the vegetation inspection be completed within the "growing period".

6.0 REPORTING

Groundwater and landfill gas monitoring results are currently reported annually. It is proposed that the results of surface water monitoring and the annual site inspection be included in the annual report. As outlined in the proposed revised Action Plan (see Section 2.4), notification of the MoE may be necessary after a monitoring round is completed, depending on the results.

7.0 SUMMARY OF RECOMMENDATIONS

The recommendations for interim and possible long-term monitoring timing and frequency for landfill gas, groundwater, surface water, site inspection and reporting are summarized in Table 4, along with a summary of the current programs. The recommended changes from the current program need to be reviewed with representatives of the MoE before implementing them.

Table 4: Summary of Proposed Interim Landfill Monitoring Program

Month	Landfill Gas			Groundwater			Surface Water			Site Inspection			Reporting		
	C	*I*	*L*	*C*	*I*	*L*	*C*	*I*	*L*	*C*	*I*	*L*	*C*	*I*	*L*
Jan			*TBD*					*O*	*TBD*						
Feb			*TBD*					*O*	*?*						
Mar			*TBD*					*O*	*?*						*?*
Apr			*TBD*					*O*	*?*		*Site Inspection*	*Site Inspection*			
May			*TBD*			*?*			*?*						
Jun		*P*	*TBD*					*O*	*?*						
Jul		*P*	*TBD*					*O*	*?*						
Aug			*TBD*					*O*	*?*						
Sep		*P*	*TBD*					*O*	*?*						
Oct		*P*	*TBD*					*O*	*?*						
Nov			*TBD*						*?*						
Dec			*TBD*					*O*	*?*						

C= current program, I = proposed interim program, L=long-term (anticipated, subject to revision)

*P = partial round (*BH102, BH103, VP07-11, VP11-09, VP11-06, VP11-07 and VP11-08)

O = water levels would be observed, and measured if deemed important

TBD = to be determined

Table 4 provides a capsule summary of many of the recommendations in this report. Golder also recommends that:

- the action levels for landfill gas monitors would be set by the procedure summarized in Figure 4 and would result in the action levels being set for individual monitors as shown in Figure 5, and the Action Plan associated with methane measurements is summarized in Figure 6;
- groundwater monitor MW99-2 be added to the list of monitors that are sampled and analyzed;
- groundwater level measurements for MW99-3 and MW99-4 be completed with each round of groundwater monitoring;
- one surface water sample be collected and analyzed for the same set of parameters as groundwater samples (the need for additional sampling would be assessed based on the results of the results); and
- the benchmarks for the measurements of surface water levels be included in future site surveys.

8.0 CLOSURE

If there are any questions regarding this report, please contact the authors.

GOLDER ASSOCIATES LTD.

Gary Barrett, Ph.D., P.Geo.
Principal

Rick Peleshytyk, P.Eng.
Principal

GB/RP/cfh

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Golder Associates Ltd. 2012. Options for Final Cover Systems, Westside Landfill.

Golder Associates Ltd. 2013a. Landfill Gas Management Plan, Westside Landfill.

Golder Associates Ltd. 2013b. 2012 Annual Operations and Monitoring Report, Westside Landfill, West Kelowna, BC.

Golder Associates Ltd. 2014. 2013 Annual Operations and Monitoring Report.

APPENDIX A

"Dobbin's Well" Log

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 56228 Owner: LORNE DOBBIN Address: ASQUITH RD Area: WESTBANK WELL LOCATION: OSOYOOS (ODYD) Land District District Lot: 3485 Plan: 18545 Lot: Township: Section: Range: Indian Reserve: Meridian: Block: Quarter: Island: BCGS Number (NAD 27): 082E082422 Well: 14 Class of Well: Subclass of Well: Orientation of Well: Status of Well: New Well Use: Private Domestic Observation Well Number: Observation Well Status: Construction Method: Drilled Diameter: 7.0 inches Casing drive shoe: Well Depth: 180 feet Elevation: 0 feet (ASL) Final Casing Stick Up: inches Well Cap Type: Bedrock Depth: 30 feet Lithology Info Flag: File Info Flag: Sieve Info Flag: Screen Info Flag: Site Info Details: Other Info Flag: Other Info Details:	Construction Date: 1986-07-10 00:00:00 Driller: Capri Drilling Well Identification Plate Number: Plate Attached By: Where Plate Attached: PRODUCTION DATA AT TIME OF DRILLING: Well Yield: 15 (Driller's Estimate) Gallons per Minute (U.S./Imperial) Development Method: Pump Test Info Flag: Artesian Flow: Artesian Pressure (ft): Static Level: WATER QUALITY: Character: Colour: Odour: Well Disinfected: N EMS ID: Water Chemistry Info Flag: Field Chemistry Info Flag: Site Info (SEAM): Water Utility: Water Supply System Name: Water Supply System Well Name: SURFACE SEAL: Flag: Material: Method: Depth (ft): Thickness (in): WELL CLOSURE INFORMATION: Reason For Closure: Method of Closure: Closure Sealant Material: Closure Backfill Material: Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From	0 to	5 Ft.	topsoil
From	5 to	12 Ft.	gravel and sands
From	12 to	30 Ft.	consol. clay and gravel
From	30 to	34 Ft.	soft bedrock
From	34 to	180 Ft.	bedrock

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Golder Associates

July 26, 2016

File: 76750-40/PR 12217

Regional District of Central Okanagan
1450 KLO Road
Kelowna, BC
V1W 3A4

Attention: Clarke Kruiswyk, Environmental Services Analyst

Dear Mr. Kruiswyk:

Re: Westside Landfill - Approval of Updated Landfill Monitoring Program

Thank you for your email dated March 10th, 2016 with the attached Updated Monitoring Program for the Westside Landfill, prepared by Golder Associates dated May 6, 2014.

Ministry staff have reviewed the Updated Monitoring Program and are in agreement with the rationale provided for the recommended changes to the landfill gas and groundwater monitoring programs. Based on the information provided, and, in accordance with Section 3.6 of Permit 12217, the interim changes to the monitoring being conducted under the Landfill Gas Management Plan (LGMP) dated February 13, 2013 as recommended in the Updated Monitoring Program are hereby approved. These interim changes must be reviewed and revised if necessary upon full implementation of landfill closure.

If an exceedance of action thresholds warrants the development of a Specific Action Plan (SAP) and the exceedance is beyond the lower explosive limit, the following would apply:

- Report to the Provincial Emergency Program (PEP) at 1-800-663-3456 and to the Ministry's non-compliance reporting mailbox at environmentalNonCompliance@gov.bc.ca; and
- Adjacent property owners must be notified. In such cases, the respective neighbours must be updated on the development and implementation of the SAP.

Ministry of Environment
South Region

Mailing Address:
Suite 200 10470-152 Street
Surrey BC V3R 0Y3

Telephone: (604) 582-5200
Facsimile: (604) 930-7119
http://www.gov.bc.ca/
http://www.gov.bc.ca/env

Regional District of Central Okanagan
July 26, 2016

This letter is without prejudice to any further action that may be taken under the *Environmental Management Act* or other relevant legislation. Contravention of this letter is a violation under the *Environmental Management Act* and may be subject to legal action.

If you have any questions or concerns, please contact Roshan D'Souza at 250-354-6365.

Sincerely,

Avtar S. Sundher, B.Sc.
for Director, *Environmental Management Act*

Ministry of Environment
South Region

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