Campbell River Environmental Committee

2353 Dolly Varden Road
Campbell River, BC
V9W 4W5
(Via email)

Attention: Leona Adams

Re: Review of Upland Excavating Landfill Application Technical Assessment Reporting

GW Solutions Inc. (GW Solutions) is pleased to provide this review of the Technical Assessment Report, and Hydrogeology and Hydrology Characterization Report pertaining to the Upland Excavating Landfill Application.

In June, 2016, GW Solutions was retained by the Campbell River Environmental Committee (CREC) to provide a technical review of the hydrogeology studies conducted in support of an application for a proposed landfill. We understand that Upland Excavating Ltd. (Upland) has submitted a waste discharge application to the Ministry of Environment (MoE) for an Operational Certificate to accommodate a landfill on Upland-owned lands at 7295 Gold River Highway. The design capacity of the facility is for 500,000 m^3 of non-hazardous solid waste to be deposited over a 20-year lifespan.

A review has been completed of the Upland application reports dated May 27, 2016, prepared by GHD Limited (GHD), and submitted to the BC Ministry of Environment, Environmental Protection Division. The Upland Application comprises several reports by GHD, including:

1. Technical Assessment Report (GHD 2016, Report 3)
2. Hydrogeology and Hydrology Characterization Report (GHD 2016, Report 2)
3. Design, Operations, and Closure Plan (GHD 2016, Report 1)
4. Geotechnical Investigation Report (GHD 2016, Report 6)

We provide review comments below on what we perceive to be potentially significant issues with a brief discussion of each issue, and, where appropriate, a request for additional information.

Site Hydrogeology

Issue:
There is insufficient characterization of the groundwater regime across and near the site.

Discussion:
GW Solutions has completed a preliminary conceptual model of the subsurface. It has used the data provided by GHD to map the piezometric conditions. GW Solutions interpretation of the data does not match GHD's interpretation. GW Solutions estimates that groundwater moves in an east - northeast direction. GHD indicates that groundwater moves in a southeast direction, as shown in Figure 1. GW Solutions interpretation (in purple), superposed to GHD's (in blue), is shown in Figure 2. GW Solutions groundwater direction closely matches the groundwater direction that has been identified at and near the Campbell River Waste Management Centre (CRWMC) landfill.

Request:

A proper characterisation of the groundwater regime is required. This is particularly required for the western half of the site because a groundwater divide may be present. If such a divide is confirmed, it would indicate that groundwater may move directly from the site to Rico Lake.

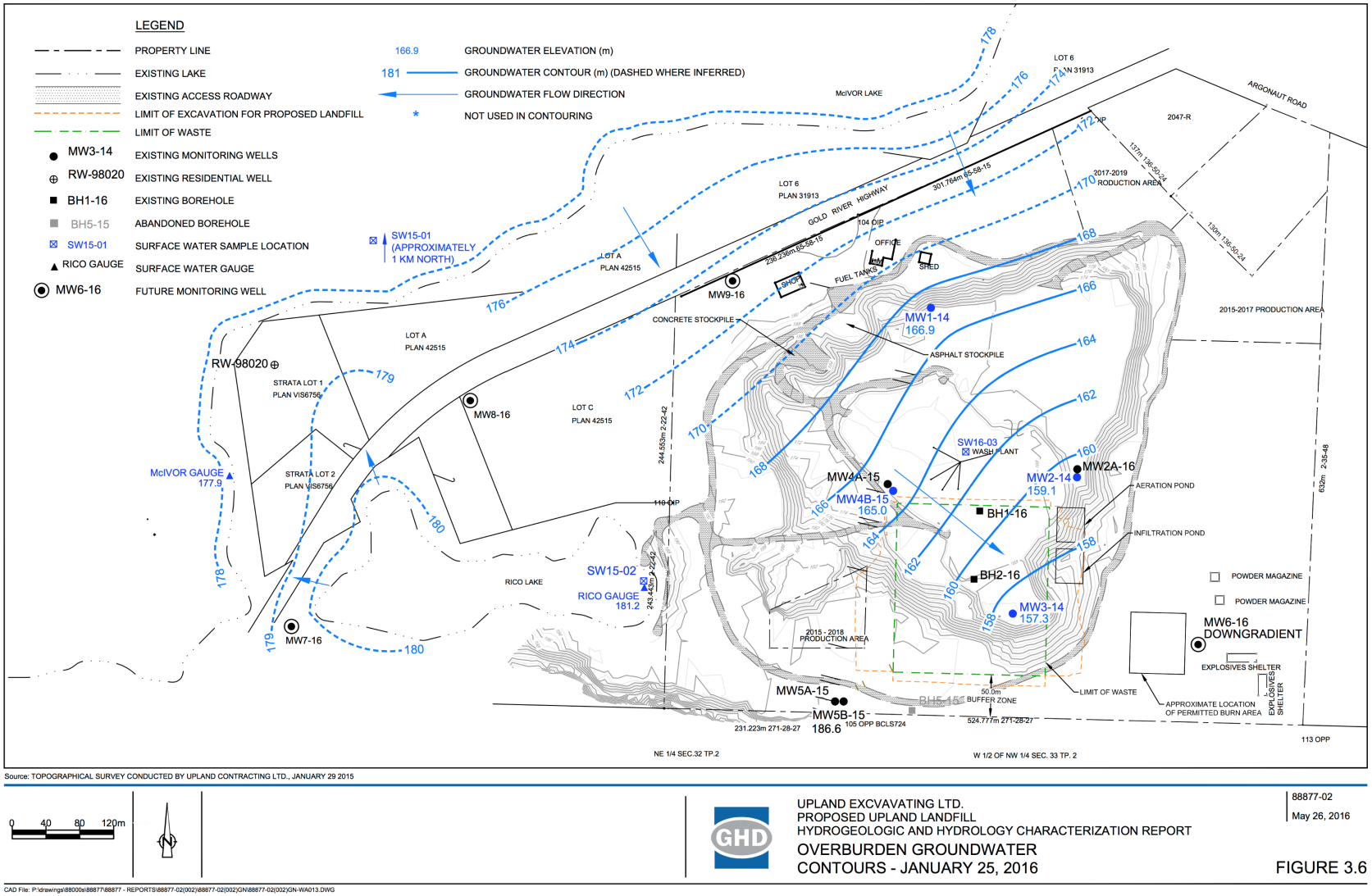


Figure 1: Groundwater direction and contours according to GHD

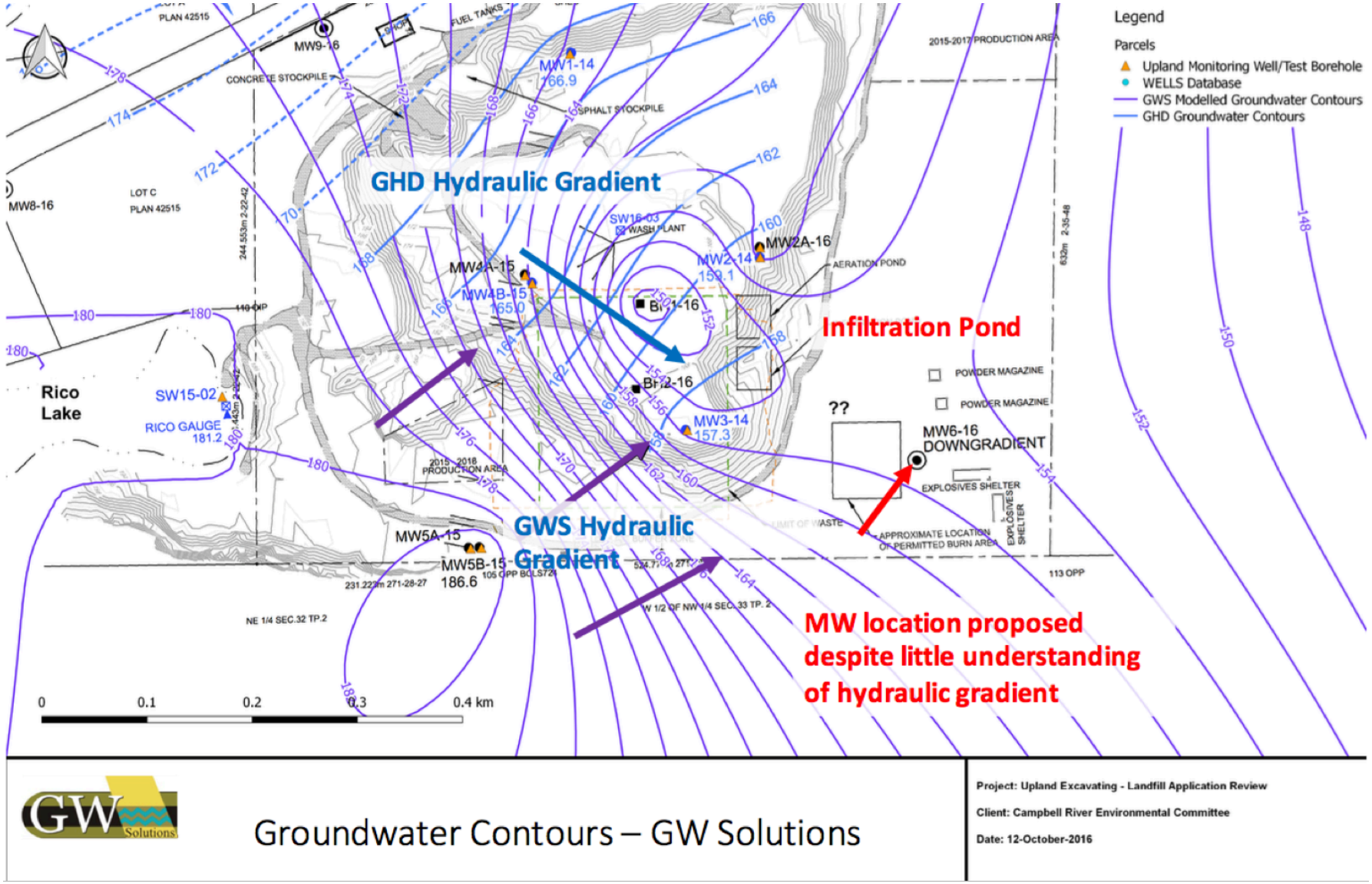


Figure 2: Groundwater regime - GW Solutions' interpretation

Issue:
There is insufficient characterization of both the lithology and the groundwater regime at and beyond the property boundary and no discussion of the future contaminant transport from the site. There is also insufficient information on the vertical and horizontal hydraulic gradients, and what may happen should contaminants be released by the proposed landfill.

Discussion:
GW Solutions estimates that the sand and gravel aquifers that were identified under the Campbell River Waste Management Centre (CRWMC) are likely present at or near the Upland site due to its proximity to the CRWMC. The lithology at and near the CRWMC site has revealed to be complex. Detailed characterisations of the subsurface completed for the CRWMC have identified both confined and unconfined aquifers. The same complexity likely extends to the Upland site. The log of BH1-16 (Figure 3 – excerpt from GHD report) reports heaving sands near 15 m depth, with a very dense layer presenting a different stratigraphy (including reported cobbles) between 11.4 m and 14 m depth. This layer could possibly be interpreted as a confining till layer, thus explaining the heaving behaviour of the sands below it. Such an interpretation has been missed by GHD. The cross sections describing the subsurface conditions provided by GHD likely oversimplify the hydrogeological conditions under the Upland site. The hydrogeological conditions may be more complex than reported by GHD.

Request:
Additional investigation is required to adequately define the hydrogeological conditions at and adjacent to the Upland site. This should be accompanied by proper groundwater monitoring to adequately characterize the groundwater regime and its seasonal fluctuation.

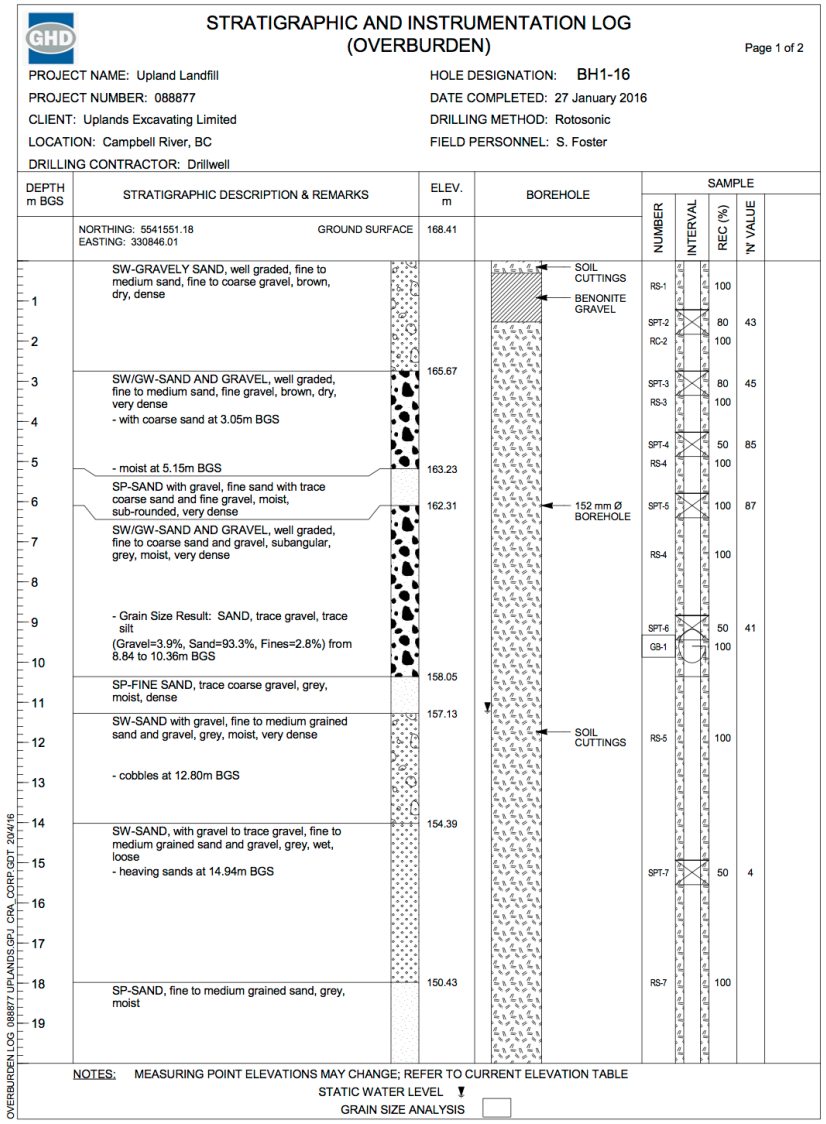


Figure 3: Log of borehole BH1-16 (Source GHD report)

Rico Lake Water Level Regime

Issue:
The GHD Reports provide no discussion of the change in Rico Lake hydrology, including the water level regime during project construction and operation, and the potential impact of the landfill.

Request:

The hydrological regime of Rico Lake and how it connects to McIvor Lake should be adequately described.

Applicable Water Quality Standards

Issue:
Groundwater exiting the site will only be monitored according to Drinking Water Quality and not to the more stringent freshwater aquatic life (FWAL) standards.

Discussion:
Groundwater transiting the property has the potential to "daylight" approximately 2 km east of the site in small tributaries to Quinsam River. GHD has recommended that freshwater aquatic life (FWAL) standards only be applied to monitoring program on the western property boundary due to the obvious proximity to Rico and McIvor lakes. The Drinking water guidelines have been recommended by GHD for all boundaries.

Request:

The more stringent FWAL guidelines should be used in the groundwater monitoring downgradient of the site to take into account the potential connection to fish bearing surface water receptors.

Off-site Downgradient Groundwater Quality

Issue:
The recommended groundwater quality monitoring wells may be inadequate in number and locations to intercept a plume emanating from the site.

Discussion:
First, it appears that the proposed downgradient monitoring well may not be located downgradient of the pond where infiltration of treated effluent will take place, if the direction of the groundwater flow has been misinterpreted, as discussed above.

In addition, the Phase 1 ESA of the CRWMC adjacent to the Upland site concluded the following:
"Due to the high flow rate and permeability of the aquifer, a plume originating from the landfill will most likely be fairly narrow. It is possible that the distribution of monitoring wells (up to several hundred meters apart) at the present time is insufficient to locate the extent of the plume (both horizontally and vertically) where the highest concentrations would be observed."

Request:
More than one downgradient monitoring well may be required to adequately monitor the potential impact of the proposed operations on groundwater quality.

In addition, information from the groundwater quality monitoring program at CRWMC should be reviewed in light of the proposed landfill. Potential cumulative effects should be assessed, in particular the risks of dissolved contaminant plumes reaching sensitive receptors (streams) downgradient of the landfill.

Landfill Water Balance

Issue:
A water balance for the site has not been defined, both at the conceptual and analytical level. This is required in order to confirm that the water and leachate management solutions proposed for the site are adequately designed and sized.

Discussion:

A conceptual water balance should account for annual precipitation, runoff, evaporation and water content of waste material. A basic estimation of the annual components of surface runoff and groundwater/leachate at the site is needed in order to assess the adequacy of the design of the leachate catchment system and the proposed monitoring plan for surface water and groundwater quality.

Groundwater mounding

Issue:

The potential for groundwater mounding underneath a developing landfill waste deposit has not been examined.

Discussion:

The report provides no discussion of the hydraulic gradients that would develop under the landfill throughout the project lifespan or post closure. A groundwater mound would likely develop beneath the landfill in response to heavy rainfall during the fall and winter. The piezometric levels of contaminated groundwater in the waste material relative to the level of Rico lake should be examined over the lifespan of the landfill, assuming that both the cover liner and the base liner will loose their integrity over time. Of particular importance is the estimation of a groundwater divide which will evolve as the landfill elevation is raised above Rico Lake and the surrounding topography.

Request:

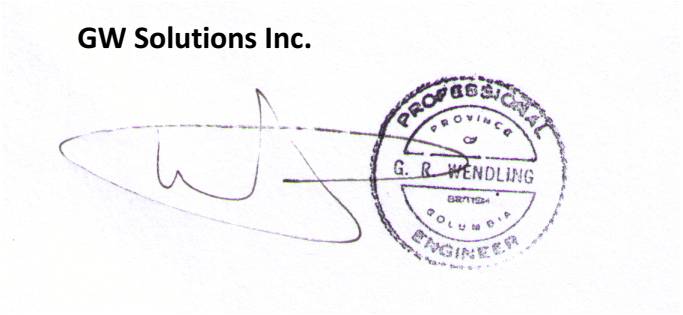
A transect from the landfill at final development stage, towards Rico and McIvor lakes, showing the estimated groundwater/leachate mounding is needed, and how this would be controlled by collector and toe draining systems. This should be clearly defined in the closure plan, as well as the long-term monitoring and maintenance, post-closure.

Closure

Conclusions and recommendations presented herein are based on available information at the time of the completed review. The work has been carried out in accordance with generally accepted engineering practice. No other warranty is made, either expressed or implied. Engineering judgement has been applied in producing this letter-report.
This letter report was prepared by personnel with professional experience in the fields covered. Reference should be made to the General Conditions and Limitations attached in Appendix 1.
GW Solutions was pleased to produce this document. If you have any questions, please contact me.

Yours truly,

GW Solutions Inc.



Gilles Wendling, Ph.D., P.Eng.
President

Appendices
Appendix 1. GW Solutions Inc. General Conditions and Limitations

APPENDIX 1

GW SOLUTIONS INC. GENERAL CONDITIONS AND LIMITATIONS

This report incorporates and is subject to these "General Conditions and Limitations".

1.0 USE OF REPORT

This report pertains to a specific area, a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment. This report and the assessments and recommendations contained in it are intended for the sole use of GW SOLUTIONS's client. GW SOLUTIONS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than GW SOLUTIONS's client unless otherwise authorized in writing by GW SOLUTIONS. Any unauthorized use of the report is at the sole risk of the user. This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of GW SOLUTIONS. Additional copies of the report, if required, may be obtained upon request.

2.0 LIMITATIONS OF REPORT

This report is based solely on the conditions which existed within the study area or on site at the time of GW SOLUTIONS's investigation. The client, and any other parties using this report with the express written consent of the client and GW SOLUTIONS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive. The client, and any other party using this report with the express written consent of the client and GW SOLUTIONS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the area or subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made. The client acknowledges that GW SOLUTIONS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

2.1 INFORMATION PROVIDED TO GW SOLUTIONS BY OTHERS

During the performance of the work and the preparation of this report, GW SOLUTIONS may have relied on information provided by persons other than the client. While GW SOLUTIONS endeavours to verify the accuracy of such information when instructed to do so by the client, GW SOLUTIONS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of GW SOLUTIONS providing the services requested, the client agrees that GW SOLUTIONS's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:

(1) With respect to any claims brought against GW SOLUTIONS by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to GW SOLUTIONS under this Agreement, whether the action is based on breach of contract or tort;

(2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless GW SOLUTIONS from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and

expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by GW SOLUTIONS, whether the claim be brought against GW SOLUTIONS for breach of contract or tort.

4.0 JOB SITE SAFETY

GW SOLUTIONS is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of GW SOLUTIONS personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The client agrees to fully cooperate with GW SOLUTIONS with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for GW SOLUTIONS to properly provide the service, GW SOLUTIONS is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE

Services performed by GW SOLUTIONS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES

The client undertakes to inform GW SOLUTIONS of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of GW SOLUTIONS may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect GW SOLUTIONS employees, other persons and the environment. These
procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay GW SOLUTIONS for any expenses incurred as a result of such discoveries and to compensate GW SOLUTIONS through payment of additional fees and expenses for time spent by GW SOLUTIONS to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES

The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by GW SOLUTIONS in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE

The client acknowledges that all reports, plans, and data generated by GW SOLUTIONS during the performance of the work and other documents prepared by GW SOLUTIONS are considered its professional work product and shall remain the copyright property of GW SOLUTIONS.

10.0 ALTERNATE REPORT FORMAT

Where GW SOLUTIONS submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed GW SOLUTIONS's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by GW SOLUTIONS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by GW SOLUTIONS shall be deemed to be the overall original for the Project. The Client agrees that both electronic file and hard copy versions of GW SOLUTIONS's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except GW SOLUTIONS. The Client warrants that GW SOLUTIONS's instruments of professional service will be used only and exactly as submitted by GW SOLUTIONS. The Client recognizes and agrees that electronic files submitted by GW SOLUTIONS have been prepared and submitted using specific software and hardware systems. GW SOLUTIONS makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.