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05-1430-117

Cariboo Regional District
Suite D, 180 North Third Avenue
Williams Lake, BC
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Attention: Mr. Rick Brundrige, MCIP

RE: GEOTECHNICAL HAZARD MAPPING FOR THE WILLIAMS LAKE FRINGE AREA OFFICIAL COMMUNITY PLAN

Dear Sirs:

As requested, Golder Associates Ltd. (Golder) is pleased to provide this Geotechnical Hazard Mapping report to the Cariboo Regional District (CRD). This report includes geotechnical hazard maps and geotechnical guidelines for development within identified geotechnical hazard areas recommended for your consideration in preparing development approval policy. The study area is the Williams Lake Fringe Area, including the City of Williams Lake and surrounding areas within the Cariboo Regional District, as shown on Figures 1 and 2. It is understood that information from this report will be considered for inclusion in the Williams Lake Fringe Area Official Community Plan (OCP).

The assessment of geotechnical hazards (geo-hazards), their locations, extent and potential effects on the suitability of the land for development has been based primarily on interpretation of available air photographs or other mapping or reports, supplemented by visual field reconnaissance within selected portions of the study area. The scope of this study does not include detailed or intrusive site investigation or analyses. Further, the scope of this study and the recommended guidelines is limited solely to geotechnical hazards. Other potential hazards, including but not limited to flooding, effects of other changes in vegetation covers from logging or natural events, is not addressed herein.

Use of this report is subject to the Statement of General Conditions which is appended after the text of this report. The reader's attention is specifically drawn to these conditions as it is essential that they be followed for the proper use and interpretation of this report.

1.0 INTRODUCTION

We understand that the CRD, working together with the City of Williams Lake, is preparing an OCP for the Williams Lake Fringe Area, a document which provides development and planning guidelines for future development within the designated bylaw area. The CRD has requested that Golder prepare geotechnical hazard mapping for inclusion in the OCP. The study area, as shown on Figure 2, extends to Brunson Lake at the southeast corner, the Chimney Creek area along the south side, and north to the Pine Valley area up to Minton Creek at the north end. The roughly rectangular study area measures approximately 20 km from north to south, and 10 to 15 km from east to west, centred roughly on the east end of the City of Williams Lake.

This report provides geotechnical input to the OCP development process, by identifying areas with potential terrain hazards which may represent constraints on future development. The objectives of this report were to provide mapping products compatible with City of Williams Lake and CRD's ArcView GIS databases, which can then be incorporated into the OCP, including rationales and explanations for any suggested zoning or development restriction guidelines made regarding potential terrain hazards identified during this study. The terrain hazards under consideration in this study consist of natural events and geotechnical conditions which may have a potential to impact development such as buildings, roads, and utilities.

We note that the BC Ministry of Water, Land and Air Protection (formerly BC MoE) has a mandate to delineate hazards from flooding along natural watercourses in BC. Consequently, delineation of flood hazard zones is outside the scope of the current project.

2.0 AVAILABLE RESOURCES

The City of Williams Lake and the CRD provided information available in their databases for their respective areas, such as digital topography with the digital elevation model (DEM)), digital orthophotos, and cadastral information including hydro and oil/gas right of ways, and roadways.

Stereo air photo coverage of the study area (various scales) was obtained, and an air photo interpretation was conducted to identify and delineate potential terrain hazards. The air photos reviewed during the study were:

Air Photo Series	Photos
15BCB99007	Nos. 113 to 117, 154 to 157
30BCB98030	Nos. 133 to 136, 179 to 185, 189 to 193
30BCC95065	Nos. 174 to 181, 220 to 227
30BCC95069	Nos. 21 to 31, 211 to 218
BC5213	Nos. 197 to 200, 233 to 236, 243 to 246
A24956	Nos. 159 and 160

Golder has conducted a number of geotechnical/ geo-hazard studies within the Williams Lake Fringe Area and City of Williams Lake. Additional geo-hazard information was available in a Ministry of Transportation (MoT) report on the Dog Creek Road Slide and a MoE report on the Paxton Road (South Lakeside) slide. Golder does not have copies of these two reports by others, which were viewed at the MoT Regional Office in Kamloops. Reports by Golder and others which were available to us and which are considered relevant to geo-hazard assessments in the study area are listed in Appendix I, together with a brief synopsis of the report content. The approximate study area for each report is identified on Figure 3.

3.0 METHODOLOGY

Prior to field work, high level aerial photographs of the study area were reviewed and large scale geo-hazard features were identified. Base maps providing topographic contours and steep slope shading were also prepared for use in subsequent field work.

Field reconnaissances were conducted of the study area from October 24 to 28, 2005, and November 3 to 4, 2005, which included both vehicle and foot traverses of the region. During the field reconnaissances, field reviews of selected features were conducted to confirm, supplement and refine the results from the air photo interpretation. Reconnaissances concentrated on steeper slope regions, generally the valley sidewalls of the study area, as geotechnical terrain hazards were not identified in the flat to gently sloping plateau areas based on the examination of available air photographs. Potential hazard areas identified during the air photo interpretation were visited to apply an element of ground truthing to areas of unclear characteristics, to clarify regions of uncertainty which arose during the initial air photo assessment, and to identify some terrain hazards that were not identified during the desk top study.

GIS mapping was conducted to provide ARC View format base maps, compatible with the City of Williams Lake and CRD's current GIS databases. The maps (and related GIS layers) were created to provide information (study area, bedrock geology, slope maps, locations of previous geo-hazard studies) and to show identified geotechnical hazard zoning. Several geotechnical hazards or recommended geo-hazard guideline zones were identified as individual layers including:

- Steep slope hazard maps for slopes of 20% and greater, and for slopes of 30% and greater;
- potential rolling rock hazard maps (slopes greater than 27.5 and 45 degrees) including a rockfall shadow area (2H:1V line projected from the upper reaches of any slopes steeper than 27.5 degrees);
- ancient and recent landslide features;
- the Asahal Dam inundation area; and
- geo-hazards guideline zones associated with the Williams Lake River Valley are shown, including steep slopes (valley sidewalls), no development zone (valley bottom), and a setback line approximately 100 metres from the crest of the valley sidewalls.

4.0 STUDY AREA PHYSIOGRAPHY AND BEDROCK GEOLOGY

The study area is located within the central interior plateau physiographic region. The interior plateau region was once an inland sea that was infilled with sediment and volcanic flows, and was later uplifted to form the present plateau. The Williams Lake area is underlain mostly by interlayered volcanic bedrock deposits (basalt, andesite, rhyolite, dacite, trachyte, related tuff and breccia, etc.), and some oceanic sedimentary rock (conglomerate, sandstone and shale), including older oceanic sedimentary rock. There is also a granitic pluton of unknown age which occurs over a limited area immediately southeast of Williams Lake.

The oldest rocks in the study area, which belong to the Cache Creek Group of the Permian to Triassic Period (about 250 to 285 million years before present (b.p.)), occupy much of west side and northwest quarter of the study area. The Cache Creek Group consists of older oceanic volcanic flows and sedimentary rocks (chert, argillite, limestone, greenstone, greywacke and conglomerate). Ultramafic rocks of the Cache Creek Group occur along the south shore of Williams Lake over the east half of the lake.

The west half of Williams Lake and the City of Williams Lake is underlain by the Tertiary Period, Eocene Epoch (24 to 55 million years b.p.) Ootsa Lake Group volcanics, consisting primarily of layered sequences of rhyolite and felsic volcanic flows, breccia and tuff.

The east half of the study area and a small portion of the west half of the study area, are underlain by Chilcotin Group plateau volcanics of Tertiary to Quaternary Period, Miocene to Pleistocene Epoch (8,000 to 24 million years b.p.), consisting of layered sequences of basaltic volcanics.

The bedrock geology of the study area, as obtained from http://webmap.em.gov.bc.ca/mapplace/minpot.bcgs.cfm, a website supported by the British Columbia Geological Survey, is illustrated on Figure 4.

The bedrock on the flat to gently sloping plateau areas is overlain by a thick blanket of glacial till, and bedrock is only exposed in steeper areas associated with valley sidewalls.

The plateau in the study area is incised by many interconnecting large and small valleys, of which Williams Lake Valley is the largest, that ultimately drain to the nearby Fraser River. The valleys in the study area originated as a network of glacial spillway channels. The valley bottoms contain thick soils including glacial fluvial, glacial lacustrine, glacial till, and colluvial fan deposits. The valley sidewalls are overlain by thinner deposits of glacial till, glacial lacustrine sediments, and colluvium.

The valley bottom and very steep sidewalls of the Williams Lake River Valley typically consist of very dense lacustrine silts with occasional lenses of sand or sand and gravel.

5.0 IDENTIFIED GEOTECHNICAL HAZARDS AND HAZARD GUIDELINES

The geotechnical hazards identified in the study area are:

- Steep slopes;
- Rockfall/ rolling rock hazards;

- Recent landslides with known earth movement;
- Ancient landslides with no known record of modern earth movement;
- Williams Lake River Valley & Escarpment; and
- the Asahal Dam Inundation Area.

It is cautioned that the focus of this assessment is on large scale geotechnical hazards, and that an overview assessment of this type is not completely comprehensive and cannot identify all geotechnical hazards in the study area. It is likely that additional geotechnical hazards will be identified over time through subsequent more detailed assessments in support of development. Further, the identification of geotechnical hazards involves interpretation of aerial photographs, which is a subjective evaluation. Consequently, more detailed assessment of hazards described herein may determine that the actual risk is greater or lesser than herein described. Accordingly, the inventory of geo-hazards should be up-dated over time as new information becomes available.

The identified and interpreted geotechnical hazards are discussed in the following sections.

5.1 Steep Slopes

A slope map which identifies various ranges of slope (20% to 30%, 30% to 27.5 degrees, 27.5 to 37 degrees, 37 to 45 degrees, and greater than 45 degrees from horizontal) throughout the study area is provided on Figure 5.

For hazard zoning purposes for development, steep slopes are commonly defined either as all slopes greater than 20% (11.3 degrees from horizontal), or as all slopes greater than 30% (16.7 degrees from horizontal). Steep slopes exist throughout the study area, mainly on the valley sidewalls, and sporadic localized pitches throughout the plateau areas, as shown on Figures 6 and 7, attached. The geotechnical hazards associated with development on steep slopes include increased potential for landslip, drainage issues, erosion, and the significant re-grading that may be required. Site regrading on steep slopes entails the construction of cut slopes, retaining walls, and the placement of structural fills.

5.1.1 Steep Slope Hazard Guidelines

Proposed development on steep ground entails special geotechnical challenges associated with steep slopes, such as access, aesthetics, ground stability, drainage and servicing requirements. It is common practice for local government to require geotechnical review of site development on steep slopes. Alternatively, local government may choose to designate a steep slope (or geohazard region) as a Development Permit Area with specific guidelines that must be met by development in that area.

Steep slope hazard criteria in common use by local government in British Columbia are slopes greater than 20%, and slopes greater than 30%. Either criterion, or alternative criteria (for example, slopes greater than 25%), would appear acceptable from a geotechnical perspective, and the selection and implementation of any such criteria is at the discretion of the local government. It is suggested that a selection of 20% be made if previous experience with local development on slopes between 20% and 30% has been problematic, indicating that greater engineering input is required.

The Westside Neighbourhood Plan, Schedule "H" of the City of Williams Lake OCP, states: "Generally speaking, it is advisable from an environmental and road access perspective to avoid the development of land that is greater than 30%", suggesting that the City of Williams Lake might prefer to use the 30% slope criterion.

A steep slope hazard map for slopes of 20% and greater is provided on Figure 6. A steep slope hazard map for slopes of 30% and greater is given on Figure 7.

5.2 Fragmental Rockfall / Rolling Rock

Fragmental rockfall refers to independent movement of individual rock fragments released from a rock face. Falling or rolling rock can be generated on any steep slopes, but are more likely to be generated on slopes greater than 37.5 degrees than on flatter slopes. Where a rock face is subject to considerable rockfall, a talus fan will develop below the rock face from the accumulation of fallen particles. However, some rock fragments, usually the largest and/or more spherical boulders, may roll considerable distances beyond the source area and/or talus fan.

Rockfall and rolling rock can run out on slopes less than 27.5 degrees, depending on the momentum of the rock (size and velocity), tree cover (smaller rocks may be stopped by trees, large rocks will not be stopped by trees), and the slope profile. Large rockfall fragments, which are the most dangerous, are usually generated from rock bluffs, but can be generated from excavations or construction.

The area that is susceptible to rolling rock hazard is sometimes called the "rockfall shadow". Through empirical research, the maximum extent of the rockfall shadow is typically defined by a 27.5 degrees (from horizontal) downward projection from the top of the talus slope.

Rockfall runout was identified as a potential hazard in most of the valleys within the study area that have moderate to steep slopes (slopes greater than 27.5 degrees). Potential falling/ rolling rock source areas consisting of slopes greater than 27.5 degrees and 37.5 degrees are shown in colour on Figure 8. Preliminary rockfall shadow areas are also delineated on Figure 8 for several selected rock source locations only. The preliminary rockfall shadow area was determined by a 2H:1V projection from the upper reaches of all slopes steeper than 27.5 degrees. This method is considered to produce a conservative estimate of the rockfall shadow limit below steep rock bluffs, and may more fairly estimate the rockfall shadow limit for more moderate slopes.

The preliminary rockfall shadow area is meant as an advisory for proposed developments that there is a potential rockfall runout hazard if a rockfall source exists above the site. As the preliminary rockfall shadow was assessed for selected areas only, it is cautioned that a potential rockfall hazard exists for all areas located on or below 27.5 degree and steeper slopes, even where a preliminary rockfall shadow area has not been delineated.

5.2.1 Rockfall / Rolling Rock Hazard Guidelines

Proposed developments that lie within the preliminary rockfall shadow area, as well as proposed developments that are located below 27.5 degree or steeper slopes (even if not within a delineated preliminary rockfall shadow area), should be evaluated, including suitably detailed field work by an experienced professional engineer or geoscientist having relevant knowledge and training, to determine if potential rockfall sources exist, to define the true rockfall shadow where sources exist, and to advise on setbacks or mitigation measures as appropriate to address the site specific rockfall hazards.

In addition, proposed developments located on slopes greater than 27.5 degrees (e.g., roads), where development exists below or could be reasonably foreseen to exist in future, should be assessed by a geotechnical engineer to assess the potential for generating rolling rocks, and stipulate construction practices that will avoid or, where avoidance is not possible, mitigate the potential hazard to properties below to achieve an acceptable level of risk.

5.3 Active Landslides

Three active landslide areas and one potentially active landslide area were identified during the study, with recent known movements that have affected development, on the south sidewall of the Williams Lake Valley, near the west end of Williams Lake. A fifth recent landslide occurred on the north wall of the Williams Lake River Valley. The identified active landslides were:

- An ancient earthflow slide feature which has affected homes on Paxton Road and Juniper Drive (South Lakeside Slide), resulting in the abandonment, demolition and removal of several homes, and reports of damage to a few other homes.
- The Hodgson Road Slide, a very large translational slide that damaged the former UCC Campus Building, and a portion of Highway 20 below the former campus site.
- The Dog Creek Road Slide, an earthflow slide located near the commencement of Dog Creek Road just east of Highway 20, which has recently become more active and possibly expanded in area.
- The Frizzi Road Slide, located on the south side of Frizzi Road and the Williams Lake River escarpment, which resulted in the destruction of one single family residence, while debris from a second slide temporarily dammed the Williams Lake River, before the debris was overtopped and eroded from the river channel.
- A potentially active set of debris slide/ debris torrent tracks located on the south side of Williams Lake, east of the South Lakeside development and west of the Russett Bluff community.

The locations of these five recently active and potentially active landslides are identified on Figure 9.

The inferred limits of the recently active portions of the South Lakeside ancient earthflow slide, that has affected homes on Paxton Street and Juniper Drive from time to time over the past 25 years, have been approximated from past experience in the area, previous slope monitoring, and airphoto interpretation.

The inferred limits of the Hodgson Road Slide were adopted from interpretations provided in an earlier study conducted by Golder Associates, which were based in large part on measurements of slope inclinometers and several ground surface mounted monitoring hubs established to measure movement. However, the aerial extent of this slide is considered approximate.

The Dog Creek Road Slide consists of an unstable road cut and earthflow in saturated soil and bedrock. The inferred limit of the active slide area is interpreted from recent reconnaissance.

The approximate limits of the Frizzi Road slide on the Williams Lake River Valley sidewall are also identified.

The Frizzi Road slide occurrences were rapid events, occurring without significant warning and over within one to several minutes. At the other slide locations, the types of ground movements identified to date are generally slow moving, posing a threat of building or infrastructure damage, but unlikely to pose a direct threat to human life.

In addition to the above, there is a group of debris torrent / debris slide tracks located on the south valley wall, east of the South Lakeside development and west of the Russett Bluff community. The potential for renewed debris slide, debris torrent, and possible snow avalanche or slide activity at these locations is unknown but, given the potential impact of such rapid slide events on future development, the risk should be assessed prior to significant development on the debris fans at the toe of the slope. These slide track locations are identified as a (potentially) active slide area on Figure 9.

5.3.1 Active Landslide Hazard Guidelines

Active landslide areas are generally unsuitable for development due to the risk to persons, buildings and infrastructure.

Such land may be suitable for low intensity uses such as storage or park space, depending on the assessed risk to persons and property. However, changes to site grading and drainage should be undertaken only following suitably detailed geotechnical investigation and assessment to determine the impact of such changes on the stability of the slide area.

Landslide areas which have been treated to permanently increase the ground stability and, after treatment, are found to satisfy the British Columbia guidelines for acceptable risk, may be considered for conventional development.

5.4 Ancient Landslides

Several ancient landslides were identified during the study, and are shown on Figure 9. Three of the identified ancient landslides are quite large, two of which measure approximately 3 km wide (one located in the Chimney Creek Valley, and the other located about 2 to 5 km southeast of Williams Lake), and one that is approximately 6 km wide (immediately opposite the centre of the City of Williams Lake, encompassing the south valley sidewall). These large ancient landslides are considered likely to have occurred near the end of the last ice age and some may even predate the last ice age; that is, they are likely about 10 to 20 thousand and possibly more years old.

The margin of stability of ground within an ancient landslide is generally unknown and may vary from place to place and over time. The stability of ancient landslides may be adversely influenced locally, or more extensively, by changes in conditions such as increased water infiltration from rainfall, irrigation or other sources, modifications to site grades by cuts, fills or toe erosion, and by infrequent but adverse environmental events such as earthquakes. Where ground stability is or becomes marginal, reactivation of portions of an ancient slide mass is possible, as in the case of the Hodgson Road Slide and the South Lakeside Slide. It is due to this potential for reactivation of portions of ancient landslides that the ancient landslide areas are identified as geohazard areas, even though the risk of ground movement may be low in some areas and higher in others. Detailed geotechnical investigation, monitoring and analysis can be used to determine site specific ground stability within an ancient slide area.

5.4.1 Ancient Landslide Hazard Guidelines

In determining whether or not to approve development, the approving authority should be aware of, and may be guided by the Municipal Insurance Association of British Columbia document titled "Guidelines for Planners, Approving Officers and Building Inspectors for Landslide-Prone Areas in British Columbia" (Skermer 2002), a copy of which is provided in Appendix III. In addition, the approving authority should be aware of and, where appropriate, be guided by the relevant sections of the Ministry of Transportation "Guide to Rural Subdivision Approvals", last modified April 2005, available on the internet at the BC Ministry of Transportation rural subdivision approvals website at http://www.th.gov.bc.ca/DA/manual1/SubdivisionManual.pdf.

A possible approach for risk management of development in ancient landslide areas might be summarized as follows:

1. Existing development areas not subject to ground movement may be considered to be stable under current conditions, although the margin of stability may be unknown. The margin of stability can be determined by geotechnical investigation and analysis conducted over time as a matter of due diligence or in support of proposed future development.

2. Proposals for new development in ancient landslide areas may be considered in the context of the existing stability conditions and standard stability criteria, and the assessed impact of the development on the global (larger scale) stability of the development site and adjoining areas, including mitigative measures, if required to maintain or enhance the current stability conditions.

3. Development proposals pending at the time of this report might be considered where the proponent can demonstrate that the global stability is not diminished by the development, and that the development proposal includes monitoring and/or treatment systems to detect changes in stability condition and address those changes if required.

5.5 Williams Lake River Valley

The Williams Lake River, which commences from the west end of Williams Lake, and travels approximately 12 km to the Fraser River, is flanked on both sides in most areas by steep and generally unstable lacustrine escarpments. The silt escarpments have numerous examples of slope failures including, but not limited to, the recent Frizzi Road Slide failures. The location of the Frizzi Road Slide is shown on Figures 9 and 10.

The lacustrine silt escarpments are vulnerable to toppling type failures of near vertical crests, and are susceptible to sliding caused by erosion (runoff), or sudden failure due to rises in groundwater levels (irrigation or an increase in rainfall). The silt escarpments may also fail if the toe is undermined by the Williams Lake River. Slide runout onto the valley floor may be considerable. Slide debris from the most recent Frizzi Road slide temporarily dammed the Williams Lake River, giving a clear example of another hazard (slide debris dam and flooding) affecting the valley bottom.

The geotechnical hazard zones associated with this section of valley are threefold:

- a crest failure hazard affecting developments near the edge of the escarpments;

- an unstable slope hazard associated with the steep silt escarpment sidewalls; and

- a slide runout hazard, potential for debris damming of the Williams Lake River, sudden flooding of the valley floor from the damming and subsequent breaching of any such debris dam.

5.5.1 Williams Lake River Valley Hazard Guidelines

Habitable buildings and areas of congregation should not be located on the Williams Lake River Valley floor, or on the sidewalls of the escarpments due to landslide, landslide runout and flood hazards.

It is recommended that a geotechnical assessment zone be established for new developments within 100 metres from the crest of the escarpments, as shown on Figure 10. Proposed developments that are located within the geotechnical assessment zone, should be assessed by a geotechnical engineer, to determine an appropriate safe building setback from the escarpment crest, and to review the intended use of the property with respect to continued slope stability. The assessment should include consideration of site grading and the proposed land use impact on water infiltration, noting that surface water infiltration into the ground near the escarpment has the potential to decrease the stability of the escarpment, and possibly trigger landslides. The assessment should include not only the development property itself, but also current or foreseeable future uses of those lands and risks to persons and property downslope of the development.

5.6 Asahal Dam Inundation Area

Recent hydrotechnical studies for upgrading of the Asahal Dam included preliminary delineation of the inundation area downstream of the dam in the (unlikely) event of a dam break. The determined primary potential inundation area determined by the assessment is shown on Figure 3. While there may be other dams in the study area, dam break inundation area information was not available to Golder for other dams.

Although, assessment of dam break inundation or other flooding hazard potential is beyond the scope of this report, the advisability of new development downstream of the Asahal Dam should be considered in the context of the Asahal Dam inundation study. Where practical, major assets should be located outside the primary inundation area, and should be designed in consideration of the potential impact of dam break inundation as described in that study.

6.0 META-DATA

More detailed mapping of the features and geo-hazards described herein is provided in the GIS meta-data which accompanies this report. A list of meta-data layers provided with this report is provided in Appendix II.

7.0 CLOSURE

We trust this report provides the information you require at this time. Please contact the undersigned if you have any questions about the content of this report, or if we can be of further assistance.

Yours truly,

GOLDER ASSOCIATES LTD.

Bruce Bosdet, M.A.Sc., P.Eng.
Principal/ Senior Geotechnical Engineer

Matt Thibeault, P.Eng.
Geotechnical Engineer

BB/MT/wf/tr

Attachments	Statement of General Conditions	
	Figure 1	Key Plan
	Figure 2	Study Area
	Figure 3	Previous Reports and Study Areas
	Figure 4	Bedrock Geology
	Figure 5	Slope Map
	Figure 6	Steep Slope Hazard Map (20% Slope Criterion)
	Figure 7	Steep Slope Hazard Map (30% Slope Criterion)
	Figure 8	Falling / Rolling Rock Hazard Map
	Figure 9	Ancient and Active Landslides
	Figure 10	Williams Lake River Valley
	Appendix I	Relevant Geo-Hazard Reports
	Appendix II	List of GIS Meta-Data Provided With This Report
	Appendix III	Municipal Insurance Association "Guidelines for Planners, Approving Officers and Building Inspectors for Landslide-Prone Areas in British Columbia"

STATEMENT OF GENERAL CONDITIONS

1.0 STANDARD OF CARE: This report has been prepared in accordance with generally accepted geotechnical engineering practices in this area. No other warranty, expressed or implied, is made.

2.0 BASIS OF THE REPORT: This report has been prepared for the specific site, design objective, development and purpose that was described to Golder Associates Ltd. (Golder) by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in this report are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Golder, unless Golder is requested by the Client to review and revise the report in light of such alteration or variation.

3.0 USE OF THE REPORT: The information and opinions expressed in this report are for the sole benefit of the Client. *No other party may use or rely upon this report or any portion thereof without GOLDER'S express written consent. GOLDER will consent to any reasonable request by the CLIENT to approve the use of this report by other parties as approved users.* The contents of this report remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, and only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof, or any copy of the report or portion thereof, to any other party without the express written permission of Golder.

4.0 COMPLETE REPORT: The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report.

In order to properly understand the suggestions, recommendations, and opinions expressed in this report, reference must be made to the whole of the report. GOLDER cannot be responsible for the use by any party of portions of the report without reference to the whole report.

5.0 NATURE AND EXACTNESS OF SOIL DESCRIPTION: Classification and identification of soils, rocks, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from these systems have been used they are specifically mentioned. Classification and identification of the type and condition of soils, rocks, geologic units are judgmental in nature. Accordingly, Golder cannot warranty or guarantee the exactness of the descriptions of insitu ground conditions set forth in the Report.

6.0 INFLUENCE OF CONSTRUCTION ACTIVITY: Construction activities can alter and damage insitu ground conditions. The influence of all anticipated construction activities on the geologic environment should be considered in formulating and implementing the final design and construction techniques.

7.0 INTERPRETATION OF THIS REPORT: This report contains information which is valid as of this date. However, conditions that are beyond our control or that may occur with the passage of time may invalidate, either partially or wholly, the conclusions and recommendations presented herein. Any person using this report for bidding or construction purposes should perform such independent investigations as he/she deems necessary to satisfy him/herself as to the subsurface conditions to be encountered and procedures to be used in the performance of work on this project.

Wherever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the information on which this report is based, the client and or any other users of this report should notify Golder as soon as possible so that Golder will be able to provide necessary revisions to its report prior to commencement of or alteration in design and construction.

8.0 CONSTRUCTION SERVICES: Post investigation services are an important and necessary continuation of this evaluation.

Final project plans and specifications should be reviewed by the geotechnical consultant prior to construction, to confirm that the full intent of the recommendations presented herein have been applied to the designs. Following review of plans and specifications, sufficient and timely observations of encountered conditions during construction should be performed to correlate the findings of this investigation with the actual subsurface conditions exposed during construction.

Observation and testing should be performed under the direction of the geotechnical consultant during construction (1) to confirm that the slopes recommended are suitable for the altered site conditions; (2) to observe and approve the stability of drainage measures; and (3) to observe fill placement and see that competent materials are properly placed and compacted.