THE CORPORATION OF THE
DISTRICT OF SUMMERLAND
COUNCIL REPORT

DATE: January 4, 2018 File: 2016-1787

TO: Linda Tynan, Chief Administrative Officer

FROM: Dean Strachan, MCIP, RPP, Director of Development Services

SUBJECT: OCP Amendment and Rezoning – 13610 Banks Crescent - Update

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STAFF RECOMMENDATION:

That Council pass the following resolutions:

1. *THAT the Review of Aquifer Protection Strategy Report by Golder Associates dated January 4, 2018 be received.*

2. *THAT the proposed amenity contribution letter from the applicants dated January 4, 2018 be received.*

3. *THAT staff be directed to schedule a Public Hearing at the earliest time and date that would meet the statutory requirements for notification and when suitable facilities are available.*

PURPOSE:

To receive the third party review report prepared by Golder Associates and the proposed amenity contribution letter from the applicant for the proposed OCP Amendment and Rezoning of 13610 Banks Crescent and consider scheduling a Public Hearing.

BACKGROUND and DISCUSSION:

1. At their meeting of October 23, 2017 Council directed staff to proceed with having a third party professional review of the proposed Aquifer Protection Strategy.

2. Staff engaged Golder Associates in November to conduct the review. A draft report was received by the District in December with the final report arriving January 4, 2018. Attached along with the final report is the combined document provided to Golder Associates to facilitate their review.

3. The Golder Associates report does not contradict findings of the applicants Aquifer Protection Strategy. However, whether the information and reports has provided adequate assurances on protection of the aquifer is up to the individual Councilors to determine.

4. The final report was forwarded to the applicant and BC Freshwater Fisheries for their review. Any responses and/or comments they may have would be forwarded to Council at the January 22, 2017 Council Meeting.

5. The letter from the applicant outlining the proposed amenities include a number of items for Council's consideration. It includes support for the staff recommendation for removal of the wooden stair case that appeared in the November, 2016 amenity proposal. The letter also includes $600,000 in upgrades to Latimer Road representing the full up-grade cost estimated by the District's Engineer. Also included is a contribution of $300,000 towards Solly Road up-grades. If following a Public Hearing, Council approved the project to proceed, staff would recommend that Council direct staff to proceed with the process to add the upgrade to a collector standard for the full length of Solly Road to the project list within the Development Cost Charges Bylaw. This would allow for the DCC's collected from the project in addition to the proposed $300,000 amenity contribution to be utilized for upgrading Solly Road. The final proposed amenity is $100,000 towards additional electrical works to the east of the development site to move wires from poles to underground. Also noted in the letter is the acknowledgment from the applicant that the required sanitary main upgrade on Lakeshore is not an amenity but instead is a direct cost to the project. Should the project be approved by Council to proceed a Master Development Agreement would be completed which would include more detailed engineering designs.

6. The applicant's proposal for amenity contribution does form a part of the information being received by Council in advance of the Public Hearing, the specifics and details would be finalized as a part of the Development Agreement that would be prepared should the application proceed to and receive Third Reading. If Council wishes to request the applicant to consider alterations to the amenity contributions proposed they should provide direction and guidance to staff for further negotiations with the applicant and reporting back to Council at their January 22, 2018 meeting prior to a potential Public Hearing. The components of amenity contribution should not substantively change following Public Hearing as substantive change could trigger a requirement for a new Public Hearing.

7. Staff reviewed the information received by Council to date and feel that sufficient information has now been received by Council to consider moving forward with scheduling a Public Hearing. Although Council could debate the information received to date now, they could also wait until after the Public Hearing input is received.

8. In addition to the statutory requirements for notification the number of people participating in the public hearing is anticipated to exceed the capacity of Council Chambers. If directed to schedule a Public Hearing staff would look to book facilities for a date towards the end of January. Dates currently be reviewed for facility bookings are January 29, 30 or 31. Should Council provide direction to schedule a Public Hearing the dates and times would be finalized, and notification begin as soon as possible.

9. The updated Comprehensive Development zoning district would be presented to Council at the January 22, 2017 meeting. The updated bylaw would reflect changes made in the application over the past year in addition to added limitations on building height tying the maximum heights to geodetic elevations instead of height above finished grade. If the application proceeds, at Third Reading of the Zoning Bylaw Amendment Bylaw, Council would be requested to consider an amended Bylaw with the updated zoning district as presented to Council prior to the Public Hearing.

LEGISLATION and POLICY:

The Bylaws related to the subject application have received second reading, a Public Hearing is recommended to be scheduled for the end of January. The Public Hearing format would be proposed to not be a single session but instead scheduled into separate sessions with temporary adjournment between sessions over one or two days.

FINANCIAL IMPLICATIONS:

There are no financial implications anticipated to result from the subject recommendation.

CONCLUSION:

The third party review report by Golder Associates has now been submitted to the District and the applicant has submitted their proposed amenity contribution letter. It is now recommended to Council that they consider proceeding to Public Hearing.

OPTIONS:

1. Move the motions as recommended by Staff.
2. Move the motion to receive the third party review report and applicant amenity contribution letter and request additional information prior to directing the scheduling of a Public Hearing.

Submitted by,

Dean Strachan, MCIP, RPP
Director of Development Services

Approved for Agenda

Linda Tynan, CAO

4 January 2018 Reference No. 1791400-001-L-Rev0

Mr. Dean Strachan, MCIP, RPP
District of Summerland
PO Box 159, 13211 Henry Avenue
Summerland, BC
V0H 1Z0

PEER REVIEW OF AQUIFER PROTECTION STRATEGY FOR PROPOSED ICASA RESORT LIVING DEVELOPMENT IN SUMMERLAND BC

Dear Sir:

As requested by the District of Summerland, Golder Associates Ltd (Golder) has completed a peer review of the geotechnical and hydrogeological components of the aquifer protection strategy submitted by Lark Enterprises Ltd. (Lark) for the proposed iCasa Resort Living development (development) in Summerland BC. The peer review has been completed in accordance with Golder's proposal to the District of Summerland dated 28 November 2017.

1.0 BACKGROUND

The proposed development is located at 13610 Banks Crescent in Summerland BC, between Highway 97 and the west shore of Okanagan Lake. The 5.8 hectare site is currently comprised of orchard and undeveloped lands with one residence. The proposed development will occupy 2.7 hectares of the site. Golder understands that the development site overlies an aquifer that feeds Shaughnessy Springs. The aquifer has not been mapped by the province and the extent and classification (yield, vulnerability, and demand) have not been determined. Shaughnessy Springs is the water source for the Summerland fish hatchery operated by the Freshwater Fisheries Society of BC (FFSBC). The FFSBC have two surface water licenses on Shaughnessy Springs with a total licenced quantity of 85 L/s (1350 US gpm). The springs are 40 m downslope and 20 m in elevation below the eastern site boundary of the development (Piteau 2017c). A simplified hydrogeological cross-section through the aquifer and overlying confining layer prepared by Piteau is shown as Figure 1 (Piteau 2017c).

- Comment on the compaction characteristics/behaviour of the soil underlying the development.
- Comment on the anticipated depth of penetration / attenuation of construction related soil vibration from construction of the proposed senior housing development.
- Provide an opinion on whether construction of the development is likely to trigger increased turbidity in the aquifer and as a result in Shaughnessy Springs, based on anticipated construction vibrations and soil types.
- Comment on Lark and its consultants' conclusions on the development's impacts on the aquifer.
- Comment on the aquifer protection strategy plan with respect to limiting and monitoring turbidity in the aquifer.
- Summarize the results of the review in a letter report.

3.0 RELEVANT INFORMATION

Golder has read the documents listed below as part of its peer review. The authors of the listed documents were advised of Golder's peer review vial email on 30 November 2017.

- CTQ Consultants Ltd et.al., (CTQ 2017) *Summerland – iCasa Resort Living Erosion and Sediment Control Work Plan*, September 2017.
- Geopacific, (Geopacific 2017) Letter to Lark Group commenting on Rock Glen 2017, 30 June 2017.
- Lark Enterprises Ltd. (Lark 2017a) Letter to Dean Strachan, Director of Development Services, Summerland BC, 27 July 2017.
- Lark Enterprises Ltd. (Lark 2017b), Letter to Summerland Mayor and Council, *Vibration-induced turbidity not a risk to Aquifer, August 14, 2017*
- Lark Enterprises Ltd. (Lark 2017c), *iCasa Resort Living, Aquifer Protection Strategy*, 29 September 2017.
- Piteau Associates Engineering Ltd. (Piteau 2016) Memorandum *Hydrogeological Assessment 13610 Banks Crescent, Summerland, BC*, 12 July 2016.
- Piteau Associates Engineering Ltd. (Piteau 2017a) Memorandum *Hydrogeological (4 January 2017 meeting summary) 13610 Banks Crescent, Summerland, BC*, 19 January 2017.
- Piteau Associates Engineering Ltd. (Piteau 2017b) *Hydrogeological Update Proposed ICASA Resort Living Development 13610 Banks Crescent, Summerland, BC*, 14 August 2017.
- Piteau Associates Engineering Ltd. (Piteau 2017c) *ICASA Site in Summerland – Discussion of Turbidity*, 19 September 2017.
- Rock Glen Consulting Ltd. (RGC 2016a), *Geotechnical Assessment for Proposed Summerland Independent & Assisted Living Development 13610 Banks Crescent, Summerland*, 30 September 2016.
- Rock Glen Consulting Ltd. (RGC 2016b), *Addendum to 30 September 2016 Geotechnical Assessment Report, Proposed Summerland Independent & Assisted Living Development, 13610 Banks Crescent, Summerland, 13 October, 2016*

4.0 PEER REVIEW COMMENTS

4.1 Aquifer Protection Strategy

FFSBC requested that the two existing site monitoring wells be used to monitor for potential vibration induced turbidity in the aquifer unless there was technical justification that the wells could not be used for that purpose. (Piteau 2017a). The aquifer protection strategy provides for baseline monitoring in Shaughnessy Springs and the two site monitoring wells to establish a natural range of turbidity at the three monitoring stations (CTQ 2017). The turbidity monitoring will continue during construction. The environmental monitor (EM) has been collecting grab samples from the Site monitoring wells to characterise background groundwater quality and plans to install continuously logging turbidity meters in the monitoring wells to monitor groundwater turbidity in the aquifer during and after construction of the development.

Monitoring for turbidity in the site monitoring wells during a turbidity event in Shaughnessy Springs, may be helpful in identifying the source, i.e. turbidity due to turbid groundwater discharging to the spring, versus turbidity caused by surface erosion into the spring. Monitoring for turbidity in groundwater would be a method to support professional opinion that construction activities present a very low risk to the aquifer. In order to provide meaningful data, the wells need to be able to produce samples that represent *insitu* groundwater turbidity/quality as characterized by the groundwater currently discharging at the springs. As an example, drinking water wells are constructed to meet common raw groundwater quality guidelines for turbidity of ≤ 1 nephelometric turbidity units (NTU).

TSS is an analytical method of measuring particulate matter 2 microns or larger in a water sample. Turbidity is an optical measurement of water clarity which is a function of suspended solids; however, there is no set correlation between TSS and turbidity. Piteau (2016) included certificates of analyses for a groundwater sample from MW1 collected on 29 June 2016 and a spring sample collected on 30 June 2016. The (TSS) concentration in the groundwater sample was 144 mg/L and the TSS concentration in the spring sample was <4.0 mg/l where 4.0 mg/L was the method reporting limit. Neither sample was analysed for turbidity.

The water sampling results show that TSS in the monitoring well groundwater sample was substantially higher than the spring water sample and it is inferred that that the groundwater sample was not reflective of groundwater flowing through the aquifer. Golder suspects that the TSS in the groundwater sample was a function of the well construction and that the well screen and sand pack was insufficiently developed to produce a representative groundwater sample using the June 2016 sampling method. Piteau completed additional groundwater sampling of MW-1 and MW-3 using low flow sampling methods to minimize agitation of the groundwater in the monitoring well with laboratory reported turbidity ranging from <0.01 to 0.3 NTU (very low turbidity).

If turbidity in the groundwater monitoring wells is measured during the background and construction phases of the project, in order to provide meaningful data Golder recommends that:

- During the background monitoring period, it is demonstrated that the turbidity of the monitored groundwater is unaffected by well completion and is similar to the spring discharge.
- Groundwater turbidity in the monitoring wells is measured at the same frequency that turbidity is measured in Shaughnessy Spring.
- The hydraulic conductivity of the sand formation the well is screened in is evaluated to demonstrate that it is characteristic of a sand aquifer and that the hydraulic conductivity of the monitoring well sand pack and surrounding formation is sufficient for natural flow through the well screens to occur, i.e. the monitoring well is suitable for low flow sampling and the combined sand pack and formation hydraulic conductivity is 10^{-6} cm/s or higher (Robbins et.al. 2008).

normal construction vibrations including soil compaction at surface. Further, turbidity within the Aquifer is unlikely to result from compaction of the Aquifer soils resulting from construction vibrations at the proposed design grade roughly 20 m above the Aquifer.

4.3 Attenuation of Construction Related Soil Vibration

Common sources of construction vibrations include vibratory or impact compactors, traffic, blasting, uneven access routes that cause heavily loaded vehicle to bounce, pile driving, dropped loads, and the like. The effects of construction vibrations on structures have been studied in detail and many jurisdictions have detailed guidelines and threshold limits for vibrations intended to limit risk of damage to structures. Research into the vibration threshold limits for other objects is generally less advanced.

A practical review of the state of knowledge and practice with respect to construction vibrations is provided in the New Zealand Transportation Agency Research Report 485 (New Zealand 2012). The principal wave types generated from vibratory sources are compression, shear and Rayleigh waves. The compression and shear waves are body waves that radiate outward through the ground from the point of impact resulting in a spherical wave front. With a 3-dimensional wave front, the compression and shear waves attenuate more quickly than Rayleigh waves. Rayleigh waves are surface waves that radiate from the point of impact resulting in a 2-dimensional wave front. When the exciting force is applied vertically to the ground, Rayleigh waves account for 67 percent of the total energy, while shear waves and compression waves account for 26 percent and 7 percent, respectively.

Accordingly, the waves of primary interest in construction vibrations are normally the Rayleigh waves which have the greater energy and travel farther with less attenuation than other vibrations. However, the amplitude of the Rayleigh surface wave reduces exponentially with depth and about 99 percent of the Rayleigh wave energy is contained within a 1 wavelength depth from ground surface, and almost 90 percent is contained within half a wavelength of ground surface. The limited depth of influence of the Rayleigh wave is reflective of the properties of the surface wave, and should not be confused with attenuation. Attenuation is the reduction in wave amplitude with distance travelled along the direction of wave travel, which for Rayleigh waves is radially along the ground surface from the point of impact.

The wavelength can be calculated from propagation velocity and frequency as follows:

Wavelength = (wave velocity / frequency).

Vibratory roller compactors are generally tuned to have an exciting frequency of 20 Hz or greater, which helps to reduce the risk of building vibration in resonance with the exciting frequency and related vibration damage to buildings, which typically have a natural frequency less than 15 Hz.

Assuming a Rayleigh wave velocity in the range of 200 to 400 m/s and an exciting frequency of 20 Hz applied at ground surface, the wavelength would be in the range of 10 to 20 m, which means that 99 percent of the Rayleigh wave energy would be contained with the upper 10 to 20 m of ground surface, and about 90 percent of the Rayleigh wave energy would be contained within 5 to 10 m of ground surface.

The conclusion that can be drawn from this is that the dominant vibrations generated by construction activities are Rayleigh waves which have greater amplitude and more limited attenuation than compression or shear waves but, as surface waves, have a limited depth of penetration into the earth. Preliminary calculations suggest that, where the depth of burial of the Aquifer is greater than 10 m below ground surface, a depth below which the Rayleigh waves effectively do not penetrate, the compression and shear body waves will become the dominant vibrations.

such events. Anomalous conditions that are identified as likely to be associated with construction can then be addressed in expeditious and effective fashion. Regular vibration monitoring should be used to assess the validity of vibration estimates which are the basis for assessments of risk.

The reference paper (Kim 2000) used to by RGC and Piteau to support their assessments of vibration attenuation is a narrow scope collection of monitoring results from specific sources that adds to but does not define the larger body of knowledge. Neither the soil conditions nor the vibration sources used in that paper have any particular relevance to the subject site. However, there are other studies that could be considered that provide a broad review of the state of knowledge and practice for construction vibration assessment and mitigation.

5.0 POTENTIAL IMPACT ON WATER TURBIDITY AT SHAUGHNESSY SPRINGS

5.1 Ground Stability at Shaughnessy Springs

It is understood that the Shaughnessy Springs emerge from many existing locations over an area of sloping ground and that, from time to time, new areas of flow temporarily emerge resulting in sloughing of the ground, causing turbidity events. The continuous water discharges combined with occasional sloughing suggests that the spring area is marginally stable at least with respect to shallow failures.

It is therefore reasonable to suspect that ground vibrations from construction may have the potential to trigger new sloughing, or an increased frequency of sloughing, in the marginally stable wet to saturated ground within or adjacent to the area of the Springs, causing turbidity. There may also be some threshold limit for vibrations below which no change in the frequency or scale of sloughing is detectable. At this time, however, the value of this threshold limit is unknown.

5.2 Aquifer Impacts

FFSBC report that Shaughnessy Springs emerge at multiple locations over an area of approximately 1.2 hectares. Piteau indicate that the proposed development will come within 40 m of the springs area (Piteau 2017c). The depth to the Shaughnessy Springs Aquifer is not known over much of the site, but at the locations of monitoring wells MW-1, MW-2 and MW-3 the depth of cover over the Aquifer is approximately 20 to 30 m or greater. Reports provided generally indicated an assumed minimum soil cover over the aquifer at the maximum depth of excavation to be about 20 m.

At such depths, the Rayleigh waves should have no significant impact, and the shear and compression waves should be attenuated. For purposes of discussion, it is assumed that the intensity of these vibrations at a depth of 20 m is small, perhaps similar in amplitude to the Rayleigh waves at 40 m distance.

For low to moderate vibrations generated in normal construction and excluding larger vibration sources such as pile driving and blasting, it is our expectation that the construction vibrations are unlikely to alter the basic structure of the aquifer and overlying soils. Consequently, it is our professional opinion that normal construction vibrations are unlikely to cause any permanent detrimental impact on the aquifer or its water quality. Additionally, under these conditions it is considered that the potential for a major change in turbidity within the aquifer is also low.

Some conditions associated with significant changes to deep aquifers include large earthquakes, blasting, pile driving, heavy vehicles bouncing on uneven haul roads (such as loaded haul trucks and scrapers) and installed piles subjected to alternating tension and compression loading, such as wind turbine foundations. Normal construction vibrations attenuated through thick soil cover are on a very much smaller scale compared to those other major intrusions.

7.0 LIMITATIONS

This report was prepared for the exclusive use of the District of Summerland. 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 Associates Ltd. (Golder) accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The report is based data provided to Golder as described in this report. Golder has relied in good faith on information provided by third parties. We accept no responsibility for any deficiency, misstatements, or inaccuracies contained in this report as a result of omissions, misinterpretations, or fraudulent or negligent acts of others.

Golder makes no warranty, expressed or implied, and assumes no liability with respect to the use of the information contained in this report at the subject Site, or any other site, for other than its intended purpose. If new information is discovered during future work, including excavations, borings or other studies, Golder should be requested to re-evaluate the conclusions of this report and provide amendments as required prior to any reliance upon the information presented herein.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

8.0 CLOSURE

We trust that this report provides you with the information you require at this time. Should you require anything further, please feel free to contact us at your convenience.

Yours very truly,

GOLDER ASSOCIATES LTD.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA K. A. BENNETT Jan 4, 2018

Kevin Bennett, PEng
Senior Groundwater Engineer

Nick Sargent, MSc, PGeo
Principal, Senior Hydrogeologist

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA B. W. BOSDET 3/Jan 4/2018

Bruce Bosdet, MASc, PEng
Principal, Senior Geotechnical Engineer

KB/BB/NS/asd

https://golderassociates.sharepoint.com/sites/21342g/deliverables/issued to client-reserved for wp/1791400-001-l-rev0/1791400-001-l-rev0-peer review 4jan_18.docx

January 4, 2018

iCasa Resort Living, Summerland BC
at Shaughnessy Green (the "Project")

ATT: **District of Summerland Mayor and Council**
RE: **Amenity Contribution**

Dear Mayor and Council,

Please accept our commitment to the following amenity contributions which shall be made to the District of Summerland over the course of development of the Project.

- $100,000 towards the removal of hydro poles east of the property, transitioning these services underground, and to occur during phase 1 which is buildings C&D.
- $600,000 towards Latimer Ave. improvements including intersection upgrade at Solly Rd., and to occur during phase 2 which is buildings A&B.
- $300,000 towards either a sidewalk connecting the Project to Hwy 97 or towards Solly Rd. improvements, and to occur during phase 3 which is Building E&F.

The total amenity contribution therefore is $1 million over the course of development of the Project.

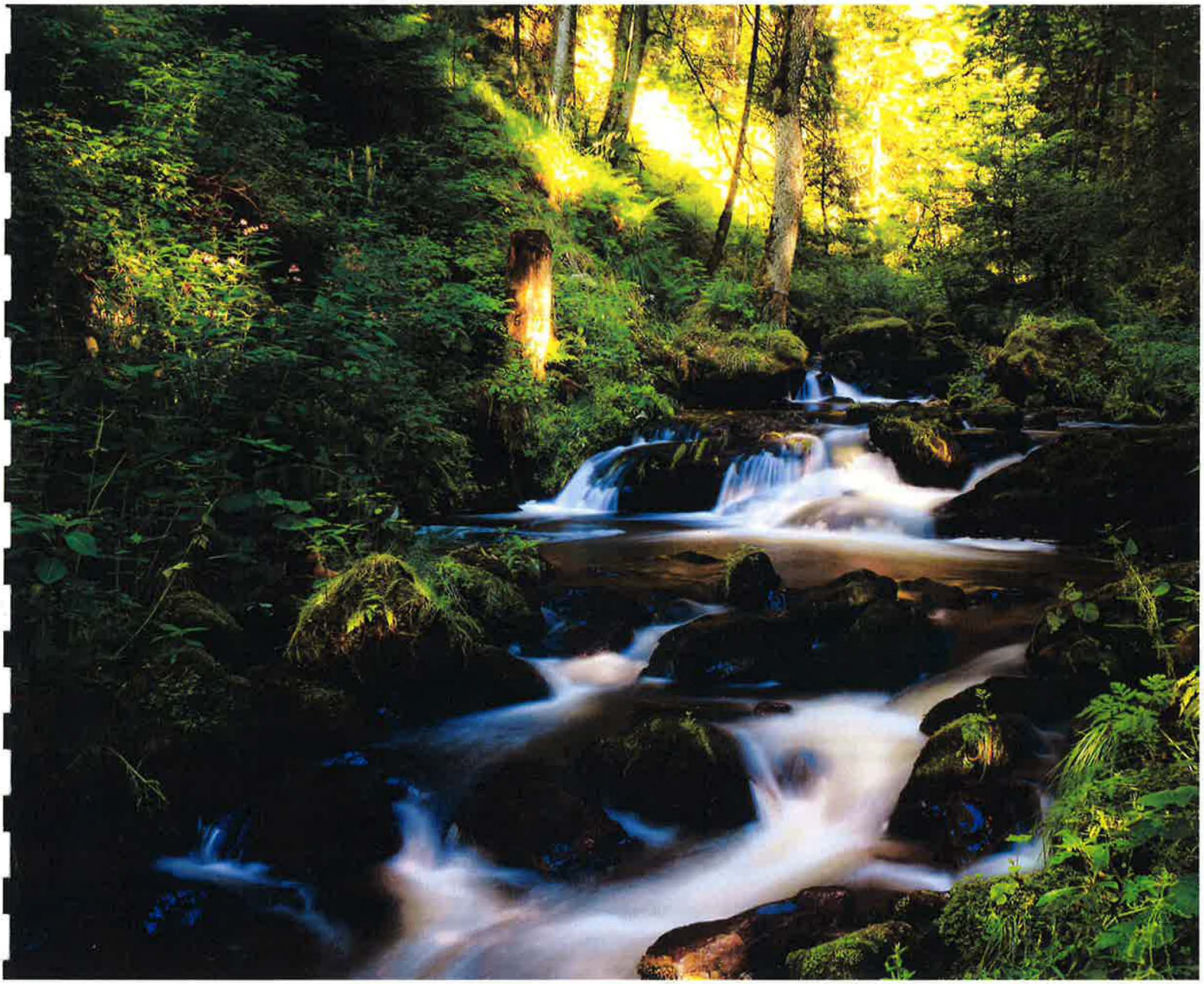
It is our understanding that a sanitary upgrade is required on Lakeshore Dr. at a cost not greater than $100,000 which will be a direct cost to the Project and associated with phase 1.

We also accept staff's recommendation to remove the option to incorporate a stairway connecting MacDonald St. to MacDonald Pl. as part of the Latimer Ave. improvements.

Sincerely,

Lark Enterprises Ltd.
Malek Tawashy,
Development Project Manager

icasa
resort living



Aquifer Protection Strategy.

LARK GROUP
DEVELOP BUILD MANAGE

September 29, 2017

iCasa Resort Living, Summerland BC
at Shaughnessy Green (the "Project")

ATT: **Dean Strachan, Director of Development Services, Summerland BC**
RE: **Aquifer Protection Strategy – Consolidated Submission**

Dear Mr. Strachan,

We understand the District of Summerland will be engaging in an independent peer review of the engineered aquifer protection strategy put forward as part of the above referenced development application. The aquifer protection strategy has been designed to protect the adjacent Shaughnessy Springs which provides the Freshwater Fisheries Society of BC a water supply sufficient for the operation of the Summerland Fish Hatchery.

In order to facilitate the peer review process we enclose a complete package of the engineering work that lead to and resulted in the final aquifer protection solution. We trust the peer review process will find our engineering to be both comprehensive and effective in protecting the FFSBC operation.

In addition to the engineering documents, we have included a construction schedule which indicates the duration where heavy machinery present and engaged in earth work activities.

Should our engineering team need to be reached we provide a contact list as follows:

Discipline	Company Name	Contact Details
Hydrogeologist	Piteau Associates Engineering Ltd. 1.250.212.7511	Remi J. P. Allard rallard@piteau.com
Erosion and Sediment Control	CTQ Consultants Ltd. 1.250.212.2238	Matt Cameron mcameron@ctqconsultants.ca
Natural Resources Biologist	Ecoscapes Environmental Consultants Ltd. 1.250.808.3474	Jason Schleppe jschleppe@ecoscapeltd.com
Geotechnical	Rock Glen Consulting Ltd. 1.250.809.9024	Paul Glen rockglen@shaw.ca
Geotechnical	Geopacific Consultants Ltd. 1.604.341.6360	Matt Kokan Kokan@geopacific.ca
Aquatic Consultant	Larratt Aquatic Consulting 1.250.769.5444	Heather Larratt heather@larratt.net

Sincerely,

Lark Enterprises Ltd.
Malek Tawashy,
Development Project Manager

LARK GROUP
DEVELOP BUILD MANAGE

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LARK GROUP
DEVELOP BUILD MANAGE

Summerland – iCasa Resort Living
Erosion and Sediment Control Work Plan

Prepared for:

Lark Enterprises Ltd.
Suite 1500, 13737 96 Avenue
Surrey, BC
V3V 0C6

Prepared by:

CTQ Consultants Ltd.
1334 St. Paul Street
Kelowna, BC V1Y 2E1

Ecoscape Environmental Consultants Ltd.
102-450 Neave Court
Kelowna, BC V1V 2M2

Piteau Associates Engineering Ltd.
788 Copping St #300
North Vancouver, BC V7M 3N2

ECOSCAPE
Environmental Consultants Ltd.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

September 2017
Our File: 16028

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1. Baseline Water Quality Program

A pre-construction (baseline) water quality monitoring program will be implemented that will document the range of naturally occurring turbidity in Shaughnessy Spring and two monitoring wells on the iCasa site.

The program will collect turbidity measurements on an hourly basis, with data being downloaded on a monthly basis. Turbidity data will be collected prior to construction for a period of 4 months to create the baseline.

2. ESC Overview

The Erosion and Sediment Control (ESC) Work Plan is prepared in accordance with the Land and Development Guidelines for the Protection of Aquatic Habitat, Ministry of Environment, and Lands and Parks, Develop with Care (2014), Ministry of Environment, Environmental Construction Monitoring (Vancouver Island University), and the Urban Runoff Control Guideline for British Columbia as per the District of Summerland Subdivision and Development Servicing Bylaw No. 99-004.

The general concept of the ESC Plan will be to collect, treat and discharge all surface storm water generated onsite to appropriate municipal storm sewers. This will be accomplished by reducing the quantity of water requiring some form of treatment and by ensuring that water generated onsite has a reduced sediment burden. Surface storm water runoff will be captured and directed towards the Stormtec Sediment Control Tanks by way of the interceptor ditch, with rock check dams or other velocity reducing structures, and temporary culverts. Settling of sediment occurs at the tank prior to being discharged directly into the municipal storm system. This method will allow for all storm water generated onsite to bypass the aquifer as requested by the District of Summerland.

A contingency berm and silt fencing installed along the south-east perimeter of the site would capture and filter surface runoff as required to protect the gulley below. Ongoing review and maintenance of all ESC measures will be conducted on a regular basis and after each rainfall event as per **Section 3** of the workplan. All measures of erosion and sediment control are to be done in accordance with MMCD section 01 57 01 - 1.2 Temporary Erosion and Sediment Controls. Environmental construction monitoring will happen on a regular schedule to inspect all erosion and sediment control measures, where the Environmental Monitor will have authority to halt work if issues of concern are identified. Further, site visit reports and monthly summary reports will be prepared and provided to the District to document compliance with the ESC Plan.

3. Description of Components

3.1 Interceptor Ditch

Interceptor ditches will be constructed so that they intercept surface runoff. Interceptor ditches will be used to capture water prior to entering the site, and to capture water prior to discharge from the site.

Interceptor ditches or swales will be constructed so that slopes have a maximum grade of 2H:1V. Ditch inverts will be constructed with a flat bottom and include velocity dissipating structures such as check dams (or approved equivalent) installed at spacing dictated by the gradient of the channel. Check dams shall be installed such that the top of the downstream check dam is equivalent to the base of the next upstream check dam to create a stepped channel profile with 0% gradient between the check dams to reduce flow velocities and mitigate channelized scour. As necessary include a rock, fiber, or fabric lining in the ditch to prevent new sediment from entering the water stream.

When ditch gradients exceed 5%, the invert of the ditch and lower 1/3 of the banks will be armored with clear fractured rock mulch sized to the dimensions and flow capacity of the temporary ditch.

3.2 Adaptive Water Management

The use of adaptive water management measures is critical on this development. Temporary interceptor ditches along the base of cut-slopes (or multiple ditches on the slope depending upon size) divert flowing water. Adaptive water management measures include the construction of temporary sumps and hard piping, or construction of temporary drainage ditches or swales as discussed above. The construction of infiltration trenches to manage minor seepages and convey drainage via permeable media (e.g. coarse sand or rock) will also provide suitable adaptive water management.

Adaptive water management also encompasses measures aimed at intercepting and diverting surface runoff around temporary stockpiles or construction materials which will be placed on paved surfaces. The establishment of temporary sandbag berms located on the upslope margin of stockpiled will divert surface runoff around the base of potentially erodible materials to preclude entrainment and transport to stormwater inlet structures.

Compacted earthen berms will be constructed to intercept and divert surface runoff around or away from an active development area or downstream areas. The berm will be constructed to a

height to preclude overtopping, and exposed materials will be suitably compacted and protected to mitigate scour resulting from channelized flows along the berm.

During the excavation process, when large areas are disturbed, a localized sump/s will be established within the disturbed area where runoff can collect and be pumped to the storm treatment system.

3.3 Silt Fence

The silt fence will define formal site perimeter protection along downslope boundaries subject to erosion.

Silt fencing is a pre-fabricated geotextile fabric with supporting stakes installed to intercept and detain transported sediment via the impoundment of flowing water behind the fence fabric, creating a depositional environment.

Silt fencing interfaces will be installed and maintained as per site ESC Plan and the manufacturer's specifications which typically require overlapping and rotation in a direction clockwise relative to the direction of surface runoff to provide an impermeable seam.

Silt fencing will not be installed on steep slopes (e.g. ≥2H:1V), rather fencing will be installed approximately 1m below or beyond the toe of slope inflection to provide appropriate sediment retention capacity. Sediment accumulations exceeding 1/3 of the fabric height will be removed. Silt fencing functions best, when water is directed through the fencing. This means that U shaped structures will be included at low elevation points to ensure water pools and passes through the silt fence, removing sediments. When needed, multiple silt fence barriers can be used. Silt fencing will, at minimum, be trenched into the ground 10-15 cm to ensure that water does not pass beneath the fencing. When a join between two sets of fencing occurs, there will no clear gaps and the joined sections will function as one unit.

3.4 Stormtec Sediment Control Tank

The steel tanks will provide sufficient capacity to detain the 100 year – 1 hour storm event to provide an environment to facilitate the settling by gravity of suspended sediment particles prior to discharge into the municipal storm system. Sediment control ponds will include a formal outlet structure which is designed to drain only the upper layer of water within the tank.

3.5 Access/Egress Pads

A formal access/egress point shall define all trucking/hauling routes to mitigate sediment tracking. The rock mulch access pad shall consist of a minimum 3" clear fractured rock, installed

at a minimum thickness of 200mm, and placed on a layer of non-woven geofabric. The geofabric mitigates the potential for the entrainment of fines from native materials below the access pad, and mitigates the potential for the access pad materials to compact into the underlying substrate. Rock mulch pads will experience frequent inspection and repair/ replacement to maintain their function and preclude offsite tracking.

4. Construction Requirements

Ongoing review and maintenance will be conducted on a regular basis to ensure all ESC requirements and objectives are met. The following sections outline the ESC General Requirements and Monitoring Schedule that will be closely followed throughout all stages of construction.

4.1 ESC General Requirements

The following requirements are described to address Section 36(3) of the federal *Fisheries Act* which states that "*no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any circumstances where the deleterious substances may enter any such water*". In this case, the spring below the site is a source water for a fish hatchery, and is being treated by this plan as being identical to a fish bearing water course. The mitigation described below will be followed as required to provide erosion and sediment control associated with identified watercourses and other surface water features or environmentally sensitive habitats identified prior to construction works commencing onsite.

A list of ESC general requirements that will be followed throughout all stages of construction is provided:

1. All work is to be undertaken and completed by the contractor in such a manner as to prevent the release of silt, sediment, or any other deleterious substances into any storm sewer or watercourse.

2. Construction activities involving ground disturbance will not be conducted during heavy rains wherever feasible to reduce the potential for sediment and erosion issues.

3. Exposed soils and stockpiles must be stabilized and covered where appropriate using geotextile fabric, poly sheeting, tarps, or other suitable materials to reduce the potential for erosion and/or mobilization of sediment resulting from rainfall, seepage, or other sources of surface water flows. Exposed embankments shall be covered and stabilized as soon as possible.

4. Clearing and grubbing will be limited as much as possible to areas being immediately worked, and roads, utilities and building sites will be developed with as little soil excavation and disturbance as possible.

5. All existing catch basins on site to have filter fabric installed prior to any work starting.

6. Silt fence will be installed as directed by the ESC Consultant along the construction limits to mitigate the risks associated with surface runoff and sediment transport and to provide a visual barrier delineating the disturbance boundary. Fencing will be staked into the ground and trenched a minimum of 10 to 15 cm to prevent flow underneath the fence, as per the manufacturer's specifications **(Appendix B)**. Silt fencing will be monitored on a regular basis and any damages or areas where the integrity and function of the fencing have been compromised will be repaired or replaced promptly. Silt fencing will be required along the southeast toe of the development footprint to protect aquatic resources downslope.

7. Erosion and sediment control materials such as silt fence, straw wattles, sand bags, erosion control matting, etc., will be readily available during construction and used to address erosion problems as they arise. The contractor must have the following erosion and sediment control measures readily available onsite:

    - Several rolls of non-woven geotextile fabric of various grades;
    - Several rolls of silt fencing with sufficient wooden stakes to allow for installation;
    - Pumps of appropriate size and hoses;
    - Tarps, poly sheeting, and sandbags; and
    - Clean drain rock.

8. Exposed cuts and fills as well as disturbed slopes will be seeded and re-vegetated as early as possible following clearing activities to encourage slope stabilization and to mitigate erosion.

9. Access roadways and other adjacent roadways must be kept clean and free of fine materials. Sediment accumulation upon the road surfaces will be removed (i.e., swept or scraped) and disposed of appropriately.

10. Prevent concentrated overland flows from occurring.

11. Prevent windblown erosion by watering, covering exposed earth or by other approved measures.

12. Erosion & sediment management works shall be installed by the contractor prior to any work in the area for which the erosion & sediment management works are intended including removals, clearing and earthworks.

13. All erosion & sediment management works to be maintained by the contractor at all times to assure proper operations. Replacement of silt fences and filter cloths (catch basins), the flushing of sewers and cleaning of sumps are required during the course of construction.

14. Remove and dispose of accumulated sediment from sediment management facilities before sediment reaching one third of the height of the facility.

15. Monitor erosion and sediment management works daily and after heavy rainfall or snow melt events. Ensure inspections area completed at end of work week or holidays.

16. Prior to construction activities, contractor to inspect all catch basins to ensure filter fabric is secure and clear of debris to prevent sediment from entering any storm system.

17. During construction, the contractor is to flush and clean storm system as required and at the completion of the project. The contractor may need to employ adaptive measures, and/or additional measures, and/or adjust the installed erosion and sediment management works to prevent the release of sediment laden water as site conditions change.

18. All erosion and sediment management work are to remain in place until all building activities are 97% complete and until vegetation has developed on exposed and disturbed areas which contribute flows to erosion and sediment management works.

4.2 ESC Monitoring Schedule

In addition to daily and post-rainfall monitoring completed by the contractor, a weekly ESC consultant review, such as that by the Environmental Monitor or onsite Engineering Technician, will be completed to ensure the effectiveness of the siltation control facilities such that the water discharging from the system is of suitable quality. The ESC consultant review will ensure all specified general requirements **Section 2.1** are met and that the siltation control facilities are operating as designed. The ESC consultant, whether it is the Engineer or Environmental

Monitor, will have the authority to stop works at any point in time to remedy or correct erosion and sediment control measures.

4.3 Water Quality Monitoring

Works must be conducted in accordance with the provincial *Water Act* and *Fish Protection Act* and the federal *Fisheries Act*. Okanagan Lake and Shaughnessy Springs are the primary water bodies in close proximity to the project area. A variety of fish species are present within Okanagan Lake and the spring is a key source of water for the Summerland Fish Hatchery.

To monitor turbidity, a continuous turbidity monitoring station will be established in the spring water. The turbidity monitor will collect measurements on an hourly basis. This level of measurement, will allow us to relate turbidity in the spring water with background data from the wells, and activities on the construction site. Water quality sampling will also be completed in situ during all Environmental Monitoring visits with a portable turbidity meter to measure ambient Nephelometric Turbidity Units (NTU). If a sample of total suspended solids (TSS) is deemed necessary, samples will be collected in 1-liter bottles and analyzed ex situ at a laboratory accredited by the Canadian Associated of Environmental Analytical Laboratories (CAEAL). As per the British Columbia Ambient Water Quality Guidelines for turbidity and TSS, the following guidelines apply:

- During clear flow periods, induced turbidity should not exceed 8 NTU above background levels at any one time for a duration of 24 hours and no more than an average of 2 NTU above background levels over a 30-day period;
- During turbid flow periods, induced turbidity natural water courses should not exceed background levels by more than 5 NTU at any time when background turbidity is between 8 and 50 NTU. When background exceeds 50 NTU, turbidity should not be increased by more than 10% of the measured background level at any one time.
- The target for total suspended solids (TSS) over background levels is 0 mg/L. The threshold is a maximum instantaneous increase of 25 mg/L over background levels when background levels are <250 mg/L, or a maximum instantaneous increase of 10% over background levels when background levels are >250 mg/L. This threshold shall not be exceeded.
- pH levels will be monitored as required.
    - Emergency measures should be implemented if downstream pH has changed more than 1.0 pH unit, measured to an accuracy of +/- 0.2 pH units from the background level, or is recorded to be below 6.0 or above 9.0 pH units.

4.4 Incident Management Plan

Spills of deleterious substances can be prevented through awareness of the potential for negative impact on aquatic habitats and with responsible housekeeping practices onsite. Maintenance of a clean site and the proper use, storage and disposal of deleterious liquids and their containers are important to mitigate the potentially harmful effects of spills and/or leaks. The following BMPs are adapted from the Standards and Best Practices for Instream Works (MOE and DFO 2014). MSDS for all potentially hazardous materials will be kept onsite during construction activities.

1. For the purposes of this report, an incident will be defined as any activity as follows:
    a. The release of any sediment laden water to the spring or water courses that exceed the standard for Aquatic Life
    b. The release of any toxic or controlled substance the exceeds levels and requires reporting to the Provincial Emergency Program (see further recommendations below)
    c. The release of any hydrocarbon, or toxic substance to the spring or areas immediately upslope of the spring of any quantity
2. Preventative measures the contractor will undertake to prevent spills from occurring include safe containment, labelling, and storage of all deleterious substances present onsite, securing stored hazardous or toxic materials to prevent vandalism or theft, disposing of used containers properly, and using appropriate personal protective equipment when handling, transporting, or disposing of hazardous or toxic substances.

3. The contractor will ensure that all equipment is inspected daily for fluid/fuel leaks and maintained in good working order.

4. Standalone fuel tanks, generators, and other potential spill sources will be surrounded by a secondary containment designed to holdback 110% of the volume of the container materials.

5. All spill events will be recorded and reported to the site supervisor and ESC Consultant. In the event of a spill, the site supervisor will be immediately notified by workers onsite. The supervisor will then be responsible for immediately contacting a mechanic (if necessary). An example Environmental Incident Report Form is provided in **(Appendix C)**.

6. In the event of any fluid spills or leaks exceeding 5 L, any spill quantity in or near water or any quantity of a hazardous material reportable spill as per the federal reportable

quantities in the *Transportation of Dangerous Goods Act*, the Spill Response Plan must be followed including immediate containment, cleanup/mitigation, and reporting.

7. Reportable Levels for Certain Substances are described in Schedule 1 of the Environmental Management Act Spill Reporting Regulation, available online at: http://www.env.gov.bc.ca/epd/codes/spill-reporting/index.htm). The following volumes should be used as a guideline for reportable spill quantities:
    - 100L of Diesel fuel or gasoline
    - 5L of Antifreeze (i.e., glycol)

8. Spills shall be contained, absorbed, and disposed of in accordance with the regulations outlined in the *Environmental Management Act* and using the following general steps:
    - Assess, monitor and prevent the hazard or threat;
    - Stabilize, contain, remove and clean up the hazard or threat;
    - Evacuate persons;
    - Recover and rehabilitate wildlife;
    - Restore wildlife habitat;
    - Take other steps to address the long term impacts resulting from the spill;
    - Report the spill event (within 48 hours).

9. Copies of contact phone numbers for notification of all the required authorities in the event of a spill/emergency response will be posted and clearly visible at the site **(see Appendix C).**

10. Spill containment kits will be kept in machines operating onsite or readily available during construction activities in case of the accidental release of a deleterious substance to the environment. Kits will generally include plugging patty, absorbent pads and/or socks, pillows, disposal bags, disposable gloves, and goggles. Sphab sorb is also recommended as a natural organic absorbent.

11. Any spills of a toxic substance will be immediately reported to the Provincial Emergency Program 24 hour hotline at 1-800-663-3456 if required.

12. In areas where contaminated sites are identified during construction activities, they will be managed for human and ecological health risks and immediately reported to the ESO. This may include collecting soil samples to submit to a lab, additional excavations to attempt delineation and consultation with contaminated sites risk management specialists.

5. SIGNATURES

Report Prepared By:

Dylan deSousa, EIT
Project Engineer
CTQ Consultants Ltd.

Report Prepared By:

Jason Schleppe, M.Sc., R.P.Bio.
Senior Natural Resources Biologist
Ecoscape Environmental Consultants Ltd.

Report Prepared By:

Matt Cameron, P. Eng., FEC
Managing Partner
CTQ Consultants Ltd.

Report Prepared By:

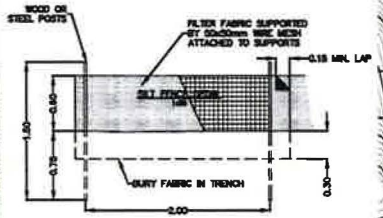
Remi Allard, M.Eng., P.Eng.
Principal Hydrogeologist
Piteau Associates Engineering Ltd.

Appendix A – ESC Plan

CONSTRUCTION EROSION AND SEDIMENTATION CONTROL PLAN

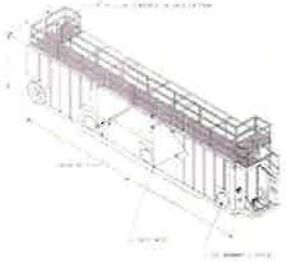
KEY POINTS:

1. SURFACE STORM WATER RUNOFF IS CAPTURED AND DIRECTED TOWARDS THE WEIR INTERCEPTOR BY WAY OF THE INTERCEPTOR DITCH. FILTRATION AND TREATMENT OCCURS AT THE WEIR PRIOR TO BEING DISCHARGED DIRECTLY INTO THE MUNICIPAL STORM SYSTEM BYPASSING THE HATCHERY.
2. A CONTINGENCY BERM AND SILT FENCING INSTALLED ALONG THE SOUTH EAST PERIMETER OF THE SITE WOULD CAPTURE AND FILTER SURFACE RUNOFF AS REQUIRED.
3. SIMILAR BERM AND SILT FENCING DETAILED WILL BE INSTALLED IN A TIERED FASHION AT THE HEAD OF THE SPRING, PROVIDING PROTECTION FROM NATIVE EARTH THAT PRESENTS A RISK OF SLOUGHING INTO THE WATER SOURCE.
4. ONGOING REVIEW AND MAINTENANCE OF ALL INSTALLATIONS WILL BE CONDUCTED ON A REGULAR BASIS AND AFTER EACH RAINFALL EVENT. (AS PER NOTE 8.)
5. ALL MEASURES OF EROSION AND SEDIMENT CONTROL TO BE DONE IN ACCORDANCE WITH MMCD SECTION 01 57 01 – 1.2 TEMPORARY EROSION AND SEDIMENT CONTROLS.

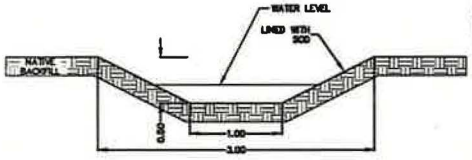


NOTES:

1. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
2. SEDIMENT MUST BE REMOVED FROM SILT FENCE WHEN IT REACHES APPROXIMATELY ONE-THIRD THE HEIGHT OF THE FENCE AND DEPOSIT OFF-SITE.
3. SILT FENCE TO BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
3. THE SILT FENCE TO BE REMOVED ONCE THE SITE IS STABILIZED.
4. FOR FURTHER DETAILS SEE CITY OF KELOWNA 'BEST MANAGEMENT PRACTICES OF EROSION AND SEDIMENT CONTROL – UPLAND WORKS'



STORMTEC OPEN-TOP WEIR STEEL TANK
N.T.S.



INTERCEPTOR DITCH DETAIL
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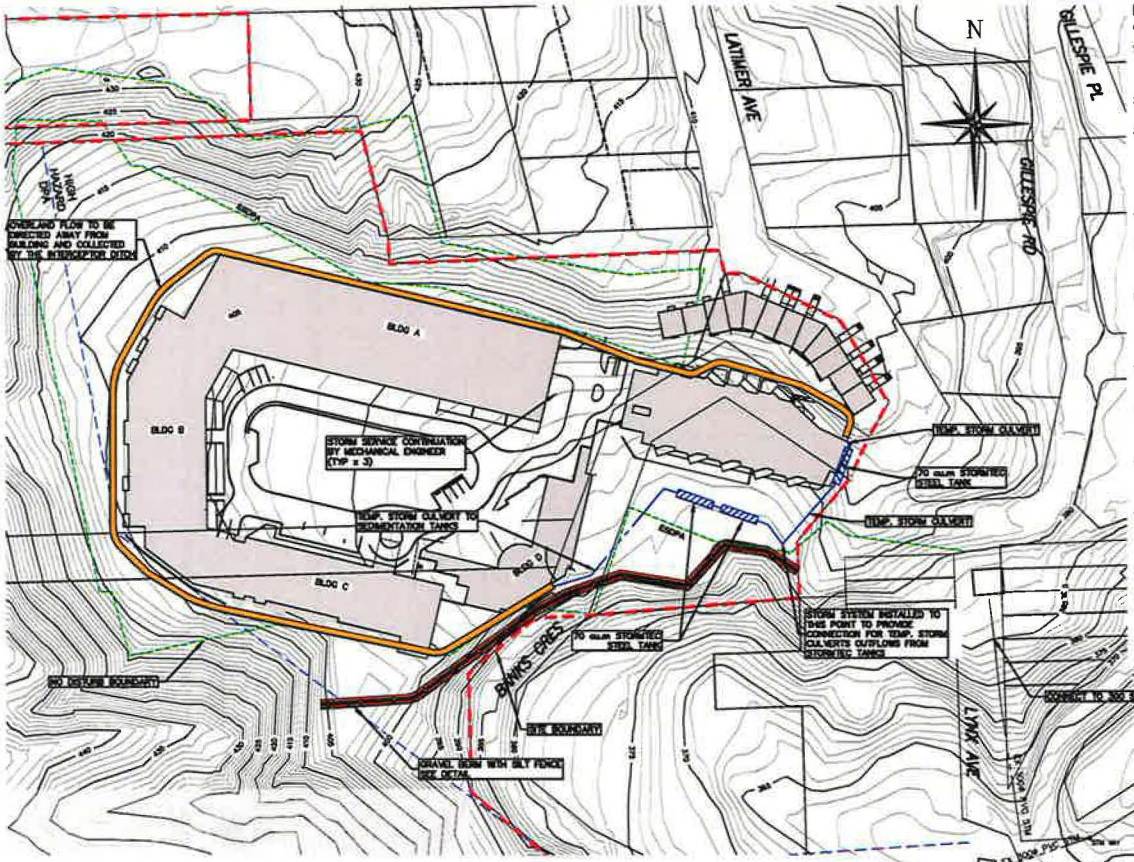


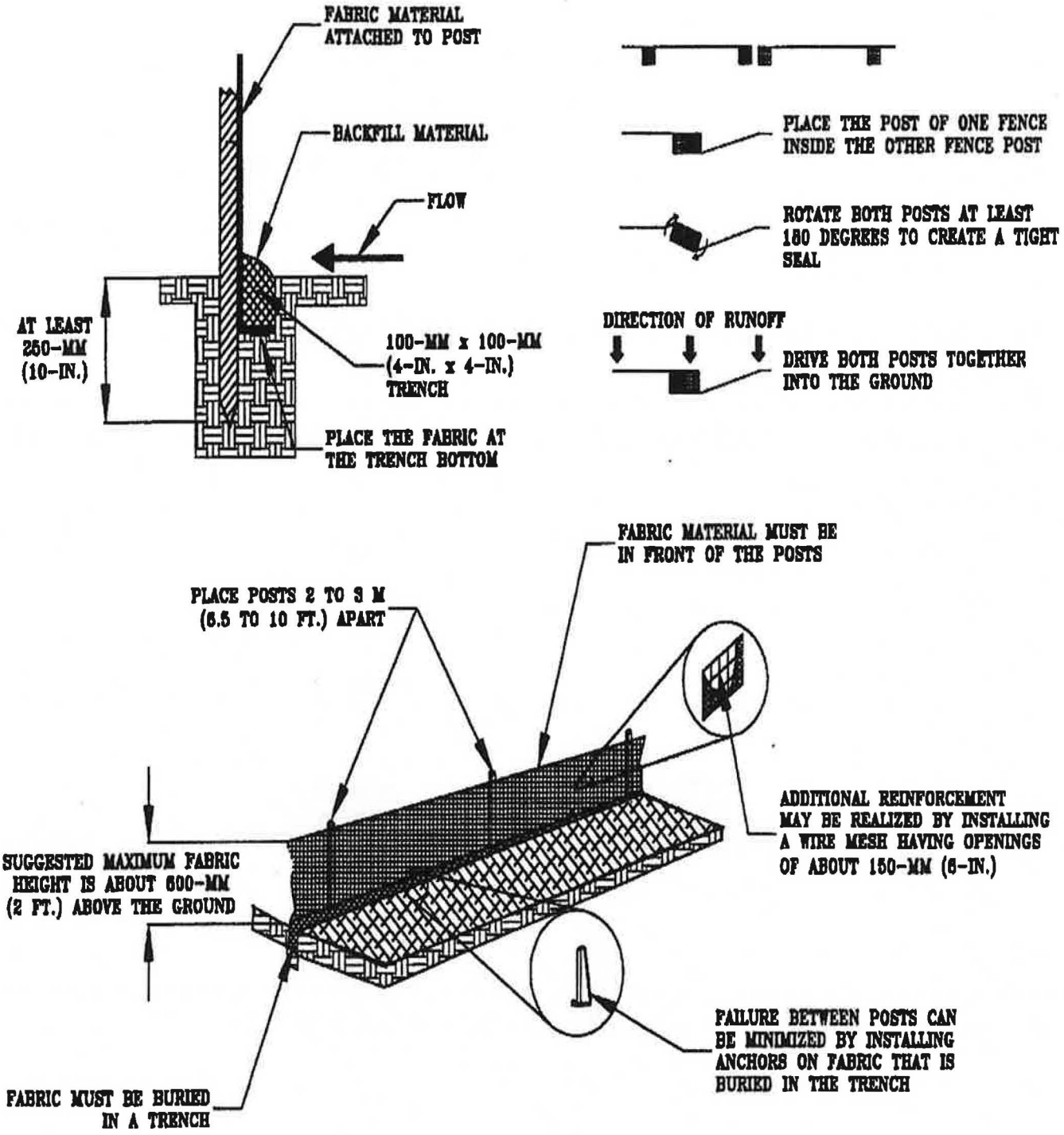
EROSION AND SEDIMENT MANAGEMENT NOTES – ALL STAGE OF CONSTRUCTION

1. ALL WORK IS TO BE UNDERTAKEN AND COMPLETED BY THE CONTRACTOR IN SUCH A MANNER AS TO PREVENT THE RELEASE OF SILT, SEDIMENT, OR ANY OTHER DELETERIOUS SUBSTANCES INTO ANY STORM SEWER OR WATERCOURSE.
2. ALL EXISTING CATCH BASINS ON SITE TO HAVE FILTER FABRIC INSTALLED PRIOR TO ANY WORK STARTING.
3. TO PREVENT EROSION:
   - 3.1. PREVENT CONCENTRATED OVERLAND FLOWS FROM OCCURRING
   - 3.2. COVER STOCKPILES, EXPOSED EARTH AND DISTURBED AREAS WITH TARP OR ANY APPROVED PRODUCT.
   - 3.3. LIMIT CLEARING AS MUCH AS POSSIBLE TO AREAS TO BE IMMEDIATELY WORKED.
4. PREVENT WIND BLOWN EROSION BY WATERING, COVERING EXPOSED EARTH OR BY OTHER APPROVED MEASURES.
5. EROSION & SEDIMENT MANAGEMENT WORKS SHALL BE INSTALLED BY THE CONTRACTOR PRIOR TO ANY WORK IN THE AREA FOR WHICH THE EROSION & SEDIMENT MANAGEMENT WORKS ARE INTENDED INCLUDING REMOVALS, CLEARING AND EARTHWORKS.
6. ALL EROSION & SEDIMENT MANAGEMENT WORKS TO BE MAINTAINED BY THE CONTRACTOR AT ALL TIMES TO ASSURE PROPER OPERATIONS. REPLACEMENT OF SILT FENCES AND FILTER CLOTHS (CATCH BASINS), THE FLUSHING OF SEWERS AND CLEANING OF SUMPS ARE REQUIRED DURING THE COURSE OF CONSTRUCTION.
7. REMOVE AND DISPOSE OF ACCUMULATED SEDIMENT FROM SEDIMENT MANAGEMENT FACILITIES BEFORE SEDIMENT REACHING ONE THIRD OF THE HEIGHT OF THE FACILITY.
8. MONITOR EROSION AND SEDIMENT MANAGEMENT WORKS DAILY AND AFTER HEAVY RAINFALL OR SNOW MELT EVENTS. ENSURE INSPECTIONS AREA COMPLETED AT END OF WORK WEEK OR HOLIDAYS.
9. PRIOR TO CONSTRUCTION ACTIVITIES, CONTRACTOR TO INSPECT ALL CATCH BASINS TO ENSURE FILTER FABRIC IS SECURE AND CLEAR OF DEBRIS TO PREVENT SEDIMENT FROM ENTERING ANY STORM SYSTEM.
10. DURING CONSTRUCTION THE CONTRACTOR IS TO FLUSH AND CLEAN STORM SYSTEM AS REQUIRED AND AT THE COMPLETION OF THE PROJECT. THE CONTRACTOR MAY NEED TO EMPLOY ADAPTIVE MEASURES, AND/OR ADDITIONAL MEASURES, AND/OR ADJUST THE INSTALLED EROSION AND SEDIMENT MANAGEMENT WORKS TO PREVENT THE RELEASE OF SEDIMENT LADEN WATER AS SITE CONDITIONS CHANGE.
11. ALL EROSION AND SEDIMENT MANAGEMENT WORK ARE TO REMAIN IN PLACE UNTIL ALL BUILDING ACTIVITIES ARE 51% COMPLETE AND UNTIL VEGETATION HAS DEVELOPED ON EXPOSED AND DISTURBED AREAS WHICH CONTRIBUTE FLOWS TO EROSION AND SEDIMENT MANAGEMENT WORKS.

SUMMERLAND
INDEPENDENT AND ASSISTED LIVING
EROSION AND SEDIMENT CONTROL PLAN
PROJECT No.16026
DRAWING No.SK-06
SCALE 1:750
March 2, 2017

CTQ

Appendix B – Silt Fence Details



Source: Malaspina University-College, 2004

ECOSCAPE
Environmental Consultants Ltd.

Project:			
Title: Typical Silt Fence Installation			
Client:			Figure No:
Location:			File No:
Date:	Dwn by:	Ckd by:	Scale: As Shown

Appendix C – Incident Report

ENVIRONMENTAL INCIDENT REPORT

Location:

_____

Date & Time of Incident:

_____

Names of Individuals Involved: (in incident, operators, providing assistance in containment or clean up)

_____

_____

_____

Nature of Incident: (circle most appropriate) - Spill - Water - Land - Trespass - Other

For Spills: (complete the following)

What has spilled? (circle most appropriate) - Hydraulic oil - Engine oil - Diesel fuel - Gasoline - Coolant –

Other (identify)

_____

Source of spill? (identify the type of equipment or container/vessel spill originated from)

_____

Estimated volume of spill (preferably in litres): _____

For Incidents other than Spills: (complete the following)

Description of Incident or Observations: (include estimate of areas affected)

_____

_____

_____

For ALL Incidents: (describe actions taken to report, contain, and clean up incident)

_____

_____

_____

_____

_____

_____

All environmental incidents to be reported as soon as practicable (all incidents must be reported within 24 hours) to:

For the _____ Project:
The Environmental Monitor

_____

and the On Site Supervisor/
Manager:_____

Page 2: (To be completed by the Environmental Monitor or Site Supervisor)

Project Name:

_____

Company: (include client, contractors or subcontractor if applicable) _____

_____

Report Received: (date and time)

_____

Additional action taken or further action required:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Photo / Document: (were photos taken? By whom? Was a photo log or other document created or referenced?)

_____

_____

Reported to: (name & association)

_____

When Reported: (date & time)

_____

Reporting Method: (circle appropriate) - In Person – 1-800 - Other phone - Email - Fax

Date Action on Incident is complete:

_____

Environmental Monitor or Site Supervisor/Manager:

_____

Print Name Signature Date

BC GOVERNMENT DANGEROUS GOODS SPILL REPORTING: 1-800-663-3456

PITEAU ASSOCIATES
GEOTECHNICAL AND
WATER MANAGEMENT CONSULTANTS

SUITE 304 - 1912 ENTERPRISE WAY
KELOWNA, B.C.
CANADA - V1Y 9S9
TEL: +1.778.484.1777 / FAX: +1.604.985.7286
www.piteau.com

Our File: 3583-M004

September 19, 2017

Lark Enterprises Ltd.
Suite 1500
13737 – 96th Avenue
Surrey, BC V3V 0C6

Attention: Mr. Myron Dirks, Project Manager

Dear Sirs:

Re: ICASA Site in Summerland – Discussion of Turbidity

Further to your request, we provide the following comments in response to recent discussions regarding turbidity at the ICASA Project Site in Summerland. Specifically we address comments raised by the Freshwater Fisheries Society (FFSBC) in their letter of September 7, 2017 to the District of Summerland (DOS).

Lark Enterprises (Lark) has committed to an erosion and sediment control plan (ESCP) during construction of the ICASA Project. The ESCP is offered in direct response to a concern raised by FFSBC that turbidity generated by surface runoff on the Project Site during construction may potentially negatively impact the water quality in Shaughnessy Spring, which is located down slope of the Project and used by FFSBC as water supply for the local fish hatchery. The Spring is located approximately 40m downslope of the Project Site and roughly at 20m lower elevation, at a point where a semi-confined sand & sand/gravel aquifer (the Aquifer) that passes beneath the Project Site daylights, or seeps, at ground surface along a slope.

The ESCP will be designed to collect, treat (if necessary) and divert surface runoff from migrating off the Project Site. The ESCP is to be supervised by an independent environmental monitor and will provide for sharing of all collected environmental data and reports. FFSBC staff will be invited to participate during regular ESCP site meetings and to participate in the identification and response/mitigation of turbidity incident events, if these occur.

Two monitoring wells drilled on the Project Site (MW-1 and MW-2) have identified silt and clay layers near ground surface overlying the Aquifer. The depth to water in the Aquifer exceeds 20m at the eastern end of the Project Site and construction will not encroach within 40m horizontal distance of the Spring.

A baseline monitoring program will be initiated prior to any construction activities on the Project Site. The intent of the baseline monitoring is to establish pre-development water quality in the Aquifer and in Shaughnessy Spring, specifically the range of naturally occurring turbidity levels in the Aquifer and in the Spring. It is proposed that the natural range of turbidity be used to establish a threshold criteria which would be incorporated into the ESCP. Exceedance of the threshold criteria would trigger mitigation measures, adaptive management and potentially, cessation of work until mitigation is achieved.

If desired, Lark is also committed to working with FFSBC to implement a post-construction monitoring program that would include water level and quality observations in the two monitoring wells on the Project Site and in the Spring.

FFSBC has expressed concern that vibration due to compaction, excavation and movement of heavy equipment at ground surface on the Project Site may mobilize turbidity in the Aquifer and in turn impact the water quality in the Spring. As stated in our letter of August 14, 2017, our opinion is that the potential for vibration at ground surface to generate turbidity in the Aquifer is negligible. This opinion is based on a 2000 technical paper by Kim & Lee entitled, "Propagation and Attenuation Characteristics of Various Ground Vibrations", which accounts for type of vibration, soil type and depth to water level. Given that vibrations at ground surface are estimated to penetrate a maximum of 12m depth and that water in the Aquifer is at 20m depth, there exists an 8m buffer and therefore no vibration induced turbidity is expected to occur. The estimated maximum horizontal distance for the dissipation of vibration generated by construction activities is also 12 m. The horizontal distance from the east end of the Project Site to the Spring is 40m and therefore a 28m horizontal buffer exists.

To support our opinion, we refer to the attached schematic of the subsurface conditions in the area of the Project Site and Shaughnessy Spring. This schematic cross section shows the best information available for surface elevation, geology, and depth to groundwater through the area.

In summary, the assessment of hydrogeological conditions at the Project Site indicates that impacts to the quantity and quality of water in Shaughnessy Spring will be negligible provided that the ESCP plan is adhered to and that construction activities, specifically vibration impacts, do not encroach within the vertical and horizontal buffer distances that have been estimated.

We trust that these comments are useful for your dialogue with the District of Summerland and the Freshwater Fisheries Society of BC.

Yours truly,

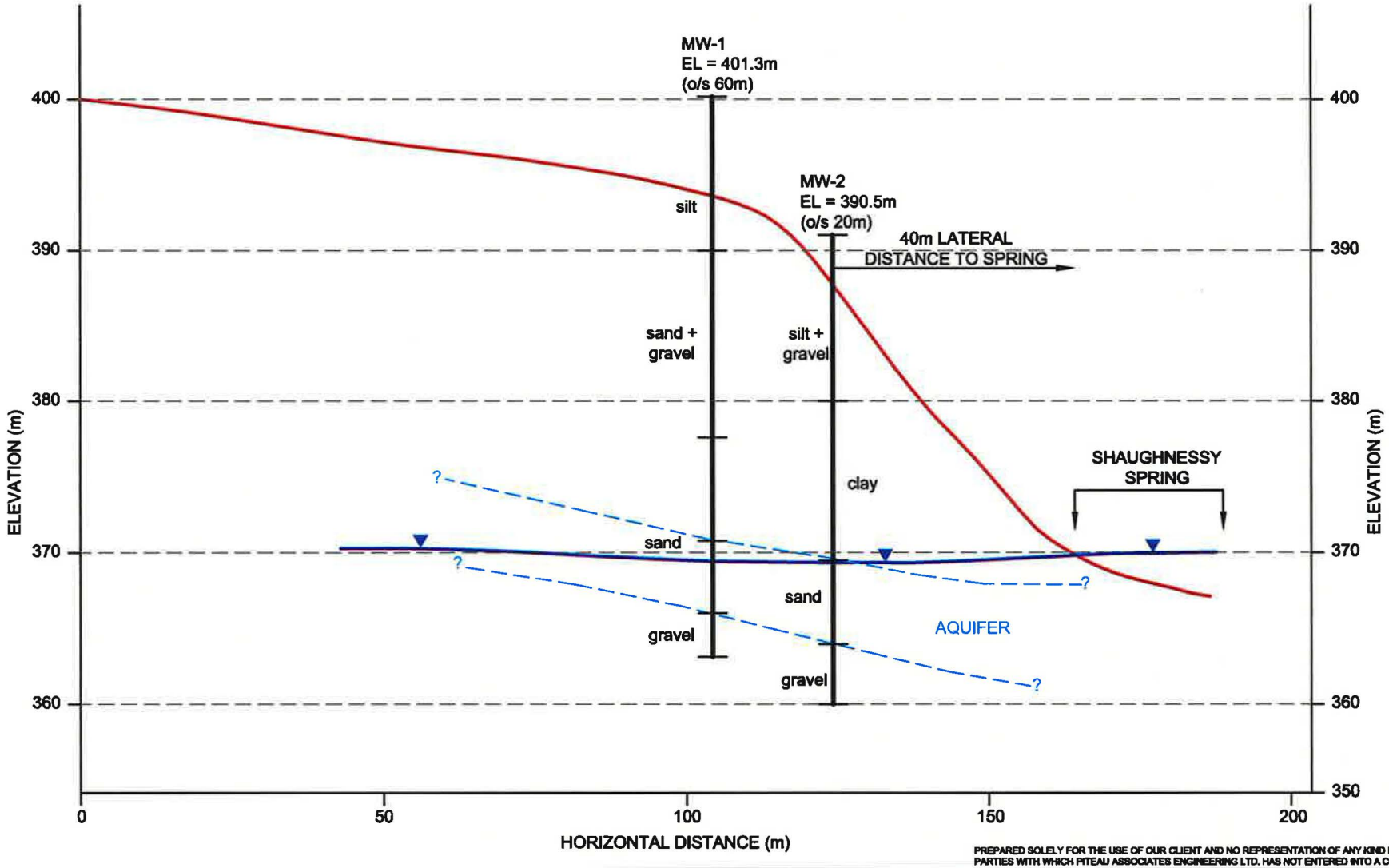
PITEAU ASSOCIATES ENGINEERING LTD.

Remi J. Allard, M.Eng., P.Eng.
Principal Hydrogeologist

RJA/skn

attachment

DWG. NUMBER: K:\3583\Cadd\3583-001.dwg (Fig 1)



0 10 20 30 40 50m

SCALE 1:1000

VERTICAL SCALE 2.5x EXAGGERATION

CTQ CONSULTANTS

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

SCHEMATIC OF GEOLOGY IN THE AREA OF THE ICASA SITE AND SHAUGHNESSY SPRING

BY:	DATE:
RA/sl	SEP 17
APPROVED:	FIG: 1

CONSTRUCTION EROSION AND SEDIMENTATION CONTROL PLAN

KEY POINTS:

1. SURFACE STORM WATER RUNOFF IS CAPTURED AND DIRECTED TOWARDS THE WEIR INTERCEPTOR BY WAY OF THE INTERCEPTOR DITCH. FILTRATION AND TREATMENT OCCURS AT THE WEIR PRIOR TO BEING DISCHARGED DIRECTLY INTO THE MUNICIPAL STORM SYSTEM BYPASSING THE HATCHERY.
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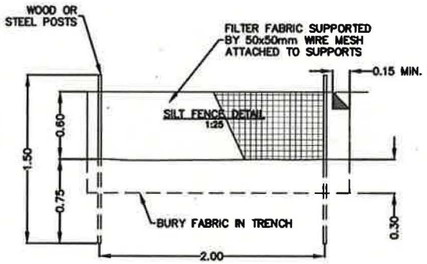

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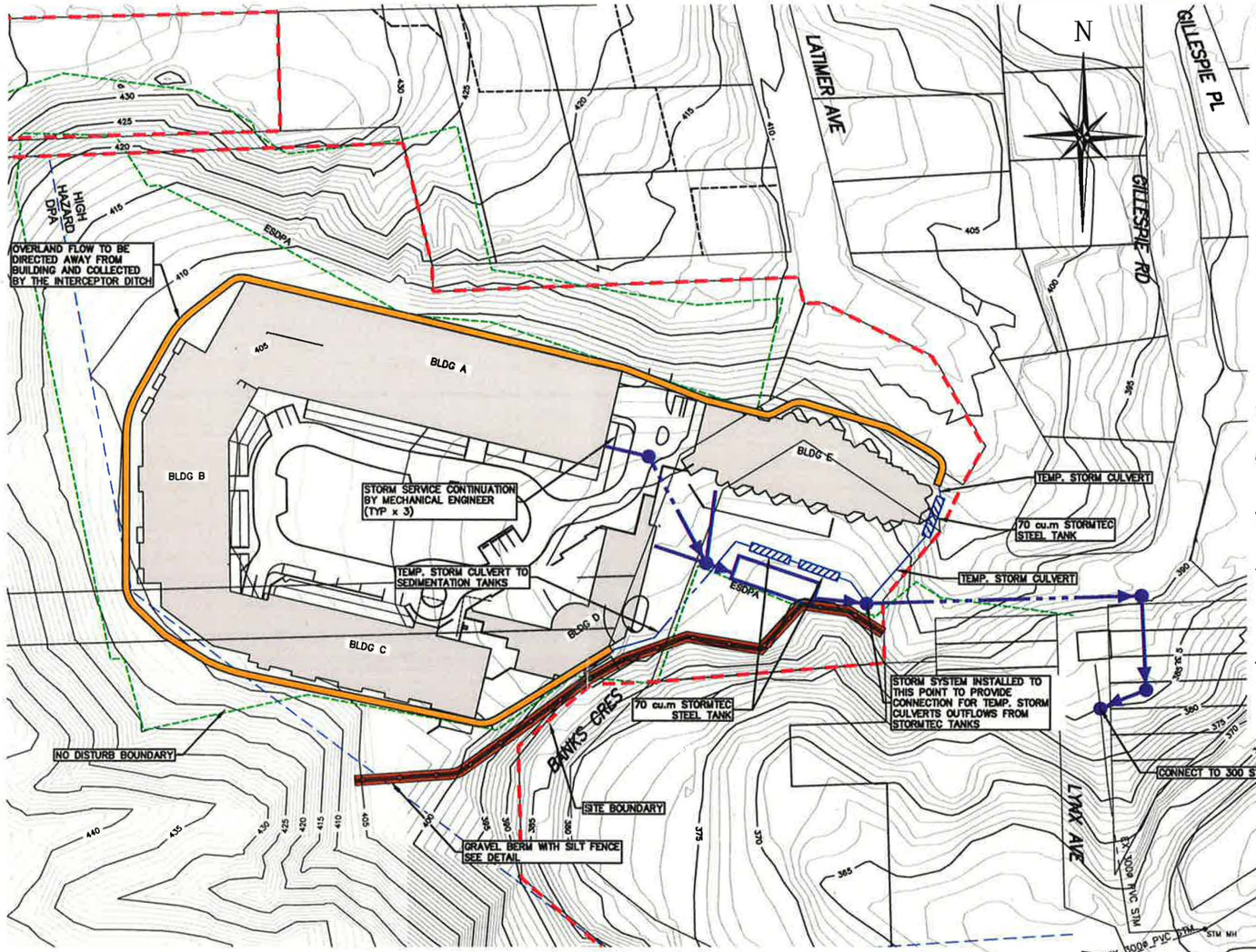
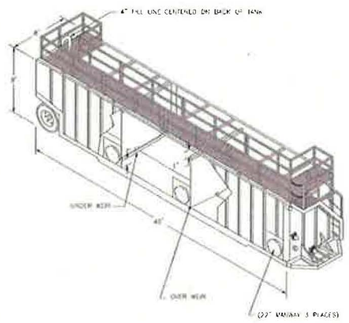
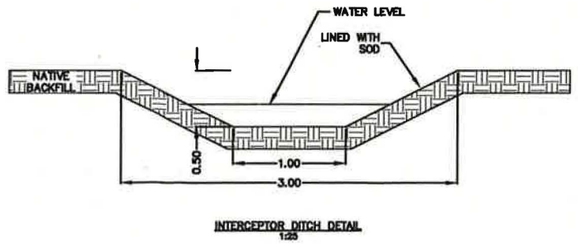
4. FOR FURTHER DETAILS SEE CITY OF KELOWNA 'BEST MANAGEMENT PRACTICES OF EROSION AND SEDIMENT CONTROL – UPLAND WORKS'





STORMTEC OPEN–TOP WEIR STEEL TANK
N.T.S.



INTERCEPTOR DITCH DETAIL
1:25

EROSION AND SEDIMENT MANAGEMENT NOTES – ALL STAGE OF CONSTRUCTION

1. ALL WORK IS TO BE UNDERTAKEN AND COMPLETED BY THE CONTRACTOR IN SUCH A MANNER AS TO PREVENT THE RELEASE OF SILT, SEDIMENT, OR ANY OTHER DELETERIOUS SUBSTANCES INTO ANY STORM SEWER OR WATERCOURSE.
2. ALL EXISTING CATCH BASINS ON SITE TO HAVE FILTER FABRIC INSTALLED PRIOR TO ANY WORK STARTING.
3. TO PREVENT EROSION:
   - 3.1. PREVENT CONCENTRATED OVERLAND FLOWS FROM OCCURRING
   - 3.2. COVER STOCKPILES, EXPOSED EARTH AND DISTURBED AREAS WITH TARP OR ANY APPROVED PRODUCT.
   - 3.3. LIMIT CLEARING AS MUCH AS POSSIBLE TO AREAS TO BE IMMEDIATELY WORKED.
4. PREVENT WIND BLOWN EROSION BY WATERING, COVERING EXPOSED EARTH OR BY OTHER APPROVED MEASURES.
5. EROSION & SEDIMENT MANAGEMENT WORKS SHALL BE INSTALLED BY THE CONTRACTOR PRIOR TO ANY WORK IN THE AREA FOR WHICH THE EROSION & SEDIMENT MANAGEMENT WORKS ARE INTENDED INCLUDING REMOVALS, CLEARING AND EARTHWORKS.
6. ALL EROSION & SEDIMENT MANAGEMENT WORKS TO BE MAINTAINED BY THE CONTRACTOR AT ALL TIMES TO ASSURE PROPER OPERATIONS. REPLACEMENT OF SILT FENCES AND FILTER CLOTHS (CATCH BASINS), THE FLUSHING OF SEWERS AND CLEANING OF SUMPS ARE REQUIRED DURING THE COURSE OF CONSTRUCTION.
7. REMOVE AND DISPOSE OF ACCUMULATED SEDIMENT FROM SEDIMENT MANAGEMENT FACILITIES BEFORE SEDIMENT REACHING ONE THIRD OF THE HEIGHT OF THE FACILITY.
8. MONITOR EROSION AND SEDIMENT MANAGEMENT WORKS DAILY AND AFTER HEAVY RAINFALL OR SNOW MELT EVENTS. ENSURE INSPECTIONS AREA COMPLETED AT END OF WORK WEEK OR HOLIDAYS.
9. PRIOR TO CONSTRUCTION ACTIVITIES, CONTRACTOR TO INSPECT ALL CATCH BASINS TO ENSURE FILTER FABRIC IS SECURE AND CLEAR OF DEBRIS TO PREVENT SEDIMENT FROM ENTERING ANY STORM SYSTEM.
10. DURING CONSTRUCTION THE CONTRACTOR IS TO FLUSH AND CLEAN STORM SYSTEM AS REQUIRED AND AT THE COMPLETION OF THE PROJECT. THE CONTRACTOR MAY NEED TO EMPLOY ADAPTIVE MEASURES, AND/OR ADDITIONAL MEASURES, AND/OR ADJUST THE INSTALLED EROSION AND SEDIMENT MANAGEMENT WORKS TO PREVENT THE RELEASE OF SEDIMENT LADEN WATER AS SITE CONDITIONS CHANGE.
11. ALL EROSION AND SEDIMENT MANAGEMENT WORK ARE TO REMAIN IN PLACE UNTIL ALL BUILDING ACTIVITIES ARE 97% COMPLETE AND UNTIL VEGETATION HAS DEVELOPED ON EXPOSED AND DISTURBED AREAS WHICH CONTRIBUTE FLOWS TO EROSION AND SEDIMENT MANAGEMENT WORKS.

SUMMERLAND
INDEPENDENT AND ASSISTED LIVING
EROSION AND SEDIMENT CONTROL PLAN
PROJECT No.16028
DRAWING No.SK-06
SCALE 1:750
March 2, 2017

CTQ

L:\General Data\Projects–2016\16028 – Summerland–Independent and Assisted Living\4–CAD\SKETCHES\16028–SK–06–ESC.dwg May 25, 2017 Dylan deSouza

ROCK GLEN CONSULTING LTD.
P.O. Box 36, Okanagan Falls, B.C. V0H 1R0
Tel: (250) 497-8290 Fax: (250) 497-8291
E-mail: rockglen@shaw.ca

September 30, 2016 RGC-1839

The Lark Group
Suite 1500, 13737 – 96 Avenue
Surrey, B.C. V3V 0C6

Attention: Malek Tawashy

Dear Mr. Tawashy:

Subject: ***Geotechnical Assessment for Proposed Summerland Independent & Assisted Living Development 13610 Banks Crescent, Summerland***

Summary

Introduction and Background

Rock Glen Consulting Ltd. (RGC) is undertaking geotechnical investigations for a planned independent and assisted living project being developed by The Lark Group. These investigations have included site reconnaissance visits, review of available topographic and soils information, excavation of test pits and drilling of test holes. Specifically, preliminary work has included the excavation of seven (7) test pits, the drilling of eight (8) test holes, the installation of two (2) monitoring wells, visual soils logging and laboratory soils testing.

This work was completed to assess the suitability of site soils to support the planned buildings and to be used as fill under structures, roads and landscape areas. Two deep test holes were drilled to depths of 27.4 m and 38.1 m to explore for an aquifer under the site that may be contributing to water flows at the nearby Shaughnessy Springs. Piteau Associates (Piteau) are providing hydrogeological consulting for these investigations. Mathew Cleary, P.Geo. from the Piteau Kelowna office was on site for the drilling of the 2 deep test holes and will be providing an assessment of potential impacts of the planned development on the local aquifer.

Test Pit and Test Hole Results

The 7 test pits were excavated on April 13, 2016 using a Yanmar 80 excavator. This relatively small excavator was needed due to access restrictions within the existing vineyard on the site. The Yanmar 80 was able to excavate to depths of 3.7 m, or about 12 feet. Test pit locations are shown on the attached *Figure 1 – Test Pit Site Plan.* RGC provided a preliminary report on the test pit findings (RGC April 22, 2016)- refer to this report for test pit logs..

The test holes drilled on the site encountered variable silt, sand and gravel to cobble deposits including water-bearing sands and gravels. The combined test pit and test hole soils information was reviewed by RGC resulting in the following interpretation of site stratigraphy and geomorphic processes.

Test pits encountered predominantly silt soils across the site. Soils in Test Pits 1, 2, 3 and 7 on the western side of the site comprise silt (rock flour) soils with significant percentages of sand and gravel as well as some cobbles and small boulders. Recent test drilling soils information, including Test Holes 1, 3, 5, 6 and 7, shows that these deposits are persistently underlain by a thick (<20 m) sand and gravel unit that is water-bearing below an elevation of 366 m.

Based upon the test drilling information, including Standard Penetration Tests (SPT's) that show these surficial "Silts" to have relative densities in the firm to very stiff range (50 to 100 kPa), RGC concludes that these materials could represent ablation till deposits. Moisture contents were low, in the dry to damp range (<10%). The test pit walls stood vertically in these materials with little to no sloughing.

In contrast, soils encountered in Test Pits 4, 5 and 6 as well as Test Hole 8 included blocky, intact lacustrine silts as exposed in the steep slopes immediately above Okanagan Lake.

The surficial approximately 1 m of soils encountered in Test Pits 4, 5 and 6 were similar to the soils in Test Pits 1, 2, 3 and 4 without the coarser fraction – no gravels or cobbles. Below 1 m, dense blocky intact silts were present. Atterberg limit testing confirms these soils to be inorganic, low to medium compressibility silts. Plasticity indices were <10 and insitu moisture contents were measured to be between 6 and 7%. SPT values for these silts were in the 12 to 30 range, or stiff to very stiff with undrained shear strength values in the 50 to 2000 kPa range – foundation soils with good bearing capacity.

Site Description

- Moderately steep to steep, predominantly silt slopes surround the natural bowl where the "Okanagan Oasis" development is proposed to be constructed. Upland areas to the west and northwest of this bowl are capped with fluvial deposits of glacial and post-glacial origin.

- The shape of the large bowl where this development is planned is similar to the shape of a smaller, and younger, bowl on the southeast corner of the project site. The lower bowl is situated at an elevation of about 365 m whereas the upper bowl ranges from 420 m down to about 395 m. A significant spring is present downstream of the lower bowl with flows collected to service a local fish hatchery.

  Both bowls show the characteristic shape of soil erosion in a strong, persistent groundwater discharge area. The lower bowl in particular has a broad, roughly circular area that funnels downslope into a narrower channel feature. This is typical of mudflows that can develop in a groundwater discharge area.

- There are other springs to the north and south of the Banks Crescent site. Rather than developing bowls, these groundwater discharge areas have eroded gullies through the local lacustrine silts.

Slope Stability Hazard Assessment

- Natural slope surround the subject property are generally stable and likely to remain so if left undisturbed. The District of Summerland requires a Landslide Hazard Assessment with a resulting Landslide Assessment Assurance Statement to confirm the stability of local slopes as part of the development approval process. RGC has completed a landslide hazard assessment.

- No large landslides were identified in the vicinity of the proposed development. Some shallow slides were noted in the gully immediately south of the planned development.

- Groundwater discharge areas are located below and to the south of the development site. These spring areas do not directly affect building and development on this property from a slope stability perspective.

- The District of Summerland approval process requires that any new construction or renovation involving a change of use in an area identified as high hazard is managed through various mitigation techniques and states that any recommendations and mitigation strategies need to be followed during construction.

- ***"Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia"*** was prepared by the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) in 2006 and revised in May, 2008. RGC followed these procedures in completing this current assessment work.

- The RGC landslide assessment process included an analysis of landslide hazards and potential consequences. The assessment analysed the potential for landslide or rockfall events to be *"a source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these."* (CSA 1997). The process coupled the potential for damage and harm with an assessment of the consequences of these events.

- The District of Summerland has not adopted criteria defining a level of landslide safety. In the absence of such criteria, RGC has compared investigation results to the level of landslide safety criteria used by the District of North Vancouver (DNV 2009).

- RGC used the District of North Vancouver *"Natural Hazards Risk Tolerance Criteria" (2009)* to define an appropriate level of landslide safety based upon slope stability factors of safety. In this regard, RGC determined that the landslide risks are acceptable for the proposed development with safety factors exceeding 1.5 for all buildings.

- Building setbacks will be required from the gully slopes adjacent to the Test Pit 7 and Test Hole 1 location as well as for any building location at the extreme east end of the property near Test Hole 2. These areas encompass portions of Buildings C and E. Preliminary siting of buildings was done using a 2H:1V setback from the toe of adjacent slopes below the building site.

- Recent stability assessments confirm that all buildings are currently situated on stable ground. This will be confirmed at the construction stage when foundation excavations and work is completed. An RGC geotechnical engineer will field review this construction work to ensure that the buildings are located on stable ground.

- RGC has appended a Landslide Assurance Letter of Agreement to this report.

Geotechnical Assessment Findings

- Based upon building elevations provided in the July 4, 2016 "Okanagan Oasis" drawing package, building/parkade foundations will be based on lacustrine silts (Buildings E), or pre-glacial sands and gravels (Buildings A, B and C), or structural fill. Building D will be founded on pre-glacial sands and gravels, with a portion possibly on lacustrine silts.

- Groundwater was not encountered in any of the test pits of shallow drill holes. The groundwater levels are indicated to be greater than 25 m of the present ground surface. As discussed a large spring is located in the gully on the south side of the site to the east of the Test Pit 7 and Test Hole 1 locations (see Site Plan).

- Excavations in both the silt till and the lacustrine silts will be stable at depths of 7 to 10 m; worker safety concerns will govern sideslopes and benching requirements.

- Building setbacks will be required from the gully slopes adjacent to the Test Pit 7 and Test Hole 1 location as well as for any building location at the extreme east end of the property near Test Hole 2. Preliminary siting of buildings was done using a 2H:1V setback from the toe of adjacent slopes below the building site.

- The intact, dense lacustrine silts will have SLS bearing capacity values in the range of 120 to 145 kPa (2500 to 3000 psf). The silt till soils will have SLS bearing capacity values in the range of 75 to 100 kPa (1500 to 2000 psf). Bearing capacities for structural fill soils will depend upon the fill thickness and the composition of the underlying soils.

- For seismic design, this property would generally be considered Site Class "C", very dense soil. This is based upon a significant depth of the intact glaciolacustrine silts or glaciofluvial sands and gravels underlying the area.

- Excavated silt till materials were subjected to grain-size analysis and Proctor testing. As visually logged in the field, these soils comprise predominantly silt sizes, or smaller (48% to 58% passing the 75 um sieve). The Proctor testing was completed on composite samples from Test Pit 1 (Samples 1, 2 & 3) and Test Pits 2 and 7 (Samples 4, 5, 9 &10).

- Proctor moisture-density relationships show possible densities in the range of 1960 to 1980 kg/m^3. Moisture conditioning of these materials would be required to increase insitu low moisture contents to the optimum moisture contents of 10% to 11% shown on the Proctor tests.

- RGC experience with these soils is that significant preparation is required to achieve uniform moisture conditioning of these silts and that they are sensitive to the addition of too much water, becoming soft and difficult to compact.

- With careful preparation, however, the silt till materials can be used for building up under roadways and parking lots as well as for landscaping fill. RGC does not recommend using silt fill as structural materials under buildings due to potential excessive settlement.

- The silts encountered on the site are marginally to poorly suited for in-ground disposal of stormwater runoff through dry wells or rock pits. That being said, if disposal locations are available away from slopes, buildings and roadways, insitu disposal of runoff water can be considered.

- The upper portion of the sands and gravels underlying the subject property are moderately permeable with estimated hydraulic conductivity values ranging around 10^{-5} m/s.

Closure

This geotechnical assessment was completed for the proposed Okanagan Oasis development at 13610 Banks Crescent in Summerland, B.C.

RGC has completed hazard assessment work and prepared a Landslide Assessment Assurance Statement that is attached to this report.

We trust that this is the information required at this time.

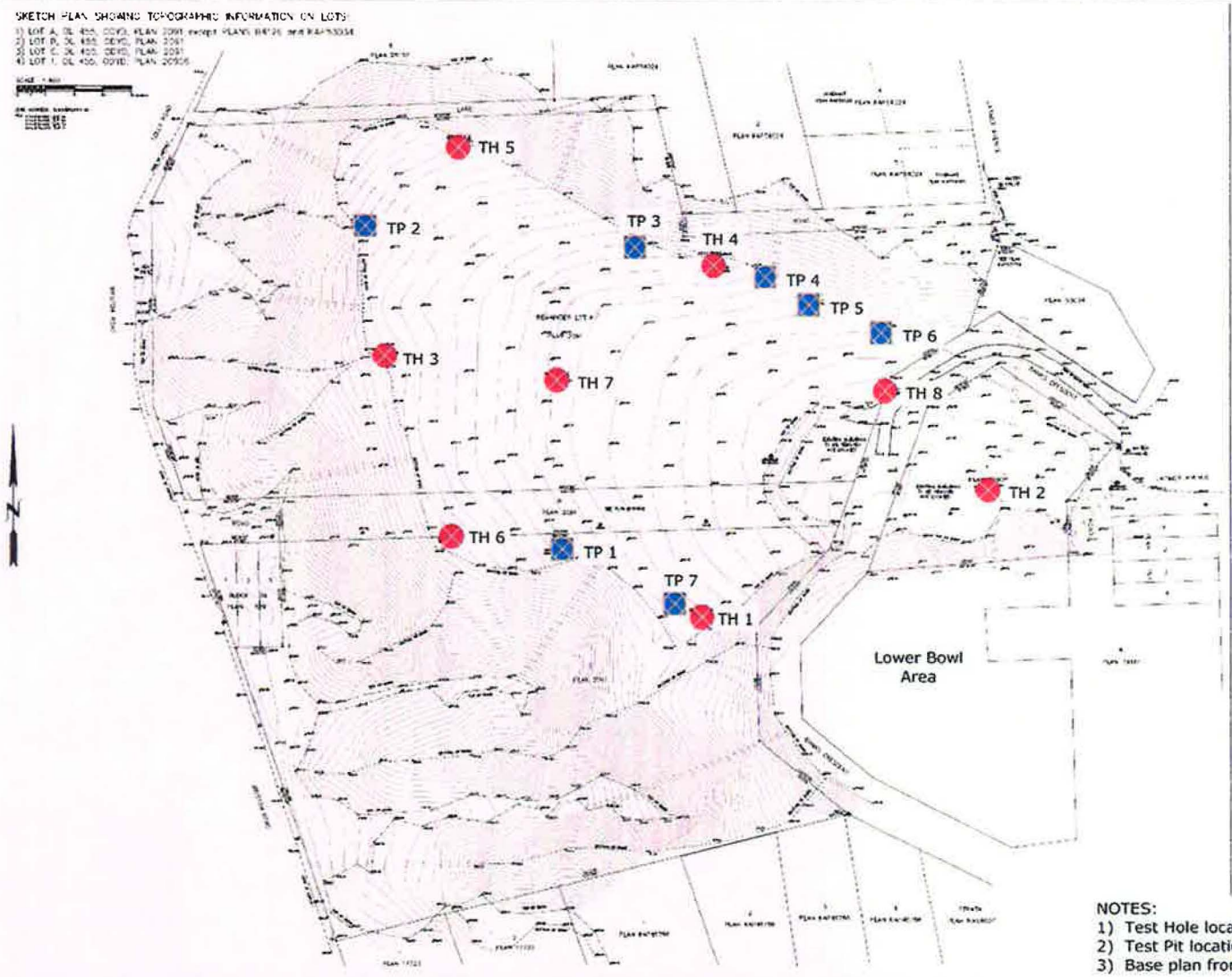
Please contact RGC with any questions regarding this work.

Yours truly,

Sept. 30, 2016

Paul Glen, P. Eng.
Rock Glen Consulting Ltd.

Attachments:
1) Figure 1: Site Plan – Test Pit & Test Hole Locations
2) Test Hole Logs
3) Landslide Assessment Assurance Statement



RGC Rock Glen Consulting

Figure 1 - Site Plan - Test Pit and Test Hole Locations

13610 Banks Road, Summerland, BC

RGC 1839

July 11, 2016

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 1

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 401.3 m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT – sandy with trace fine gravel and clay, stiff to very stiff, dry, brown.	1				
	2	1-1	SS	●	
	3				
	4	1-2	SS	●	
	5	1-3	SS	●	
	6				
	7	1-4	SS	●	
	8	1-5	SS	●	
	9				
	10	1-6	SS	●	

Investigation Date: June 13, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG/AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 1

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 401.3 m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SAND & GRAVEL – silty, compact, damp, brown.	11	1-7	G		
	12				
	13	1-8	G		
- Silt layer	14				
	15	1-9	G		
	16	1-10	G		
- Silt layer	17				
	18				
- Silt layer	19				
	20				

Investigation Date: June 13, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG/AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 1

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 401.3 m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SAND & GRAVEL – silty, compact, damp, brown.	21				
	22				
- Gravel layer (45-60 cm)	23				
	24				
	25				
	26				
	27	1-11	G		
	28				
	29				
	30	1-12	G		

Investigation Date: June 13, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG/AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 1

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 401.3 m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SAND – fine to medium grained, trace gravel, compact, damp to moist, brown.	31	1-13	G		
	32				
	33				
	34				
- Water at 35m	35				
GRAVEL – fine to medium grained, some sand, compact, wet, mottled-rusty brown.	36	1-14	G		
	37	1-15	G		
	38				
E. O. H. at 38.1m Installed monitoring well 51mm (2") diameter; screened from 30.5 to 38.1m.	39				
	40				

Investigation Date: June 13, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG/AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 2

Client: Lark Group

Page 1 of 3

RGC File No.: RGC – 1839

Elevation: 390.5m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT – hard, dry, brown.	1				
	2	1-1	SS	●	
	3				
SAND & GRAVEL – compact to dense, dry, brown.	4	1-2	SS	●	
	5	1-3	SS	●	
SILT – stiff, moist, brown.	6				
	7	1-4	SS	●	
SAND – some silt, trace clay, moist to wet.	8	1-5	SS	●	
	9				
- Very wet layer at 9m		1-6	SS	●	
	10	1-7	G		

Investigation Date: June 14, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 2

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 390.5m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
CLAY – SILTY – firm, moist.	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

Investigation Date: June 14, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 2

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 390.5m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT – CLAYEY, firm, moist.	21 22 23 24				
SAND – some silt, damp.	25 26				
SAND & GRAVEL – compact, wet.	27 28	1-8	G		
E. O. H. @ 30.5m. Installed monitoring well. 51mm (2") diameter; screened from 24.4m to 29.0m.	29 30	1-9	G		

Investigation Date: June 14, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 3

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 412.4m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT & GRAVEL – coarse gravel, some fine sand, stiff to very stiff, dry, brown.	1	1-1	SS	•	
	2				
	3	1-2	SS	•	
	4				
	5	1-3	SS	•	
SAND & GRAVEL – some silt, compact, dry to damp, brown.	6	1-4	SS	•	
	7				
	8	1-5	SS	•	
E.O.H. @ 8.2m	9				
	10				

Investigation Date: June 16, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 4

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 404.6m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (spt) Blows/ft (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT	1				
SILT – very stiff, dry, desiccated, crumbly w/partings, brown.	2	1-1	SS	•	
	3	1-2	SS	•	
SILT – rock flour, compact to dense, very stiff, dry to damp.	4				
	5	1-3	SS	•	
	6				
	7	1-4	SS	•	
	8	1-5	SS	•	
E.O.H. at 8.2m	9				
	10				

Investigation Date: June 15, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 5

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 415.4m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT – rock flour, firm, loose, dry.	1–3	1-1	SS	• at ~10	
		1-2	SS	• at ~10	
SAND – fine to medium, compact to loose, silty clay, moist.	4	1-3	G		
SAND & GRAVEL – medium grain with some medium to coarse (1") gravel, dense.	5	1-4	SS	ROCK • at ~20	
		1-5	SS		
	6	1-6	SS	• at ~40	
	7	1-7	G		
	8	1-8	SS	ROCK > 50 • at ~40	
E.O.H. @ 8.2m	9–10				

Investigation Date: June 15, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 6

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 411.8m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT – firm, dry-desiccated, brown.	1–2	1-1	SS		
SILT – some sand and fine gravel, stiff, dry, brown.	3–5	1-2	SS		
		1-3	SS		
SAND & GRAVEL – fine to coarse, compact to dense, dry to moist, brown.	6–8	1-4	SS	ROCK	
		1-5	SS		
E.O.H. @ 8.2m	9–10				

Investigation Date: June 16, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 7

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 402.5m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (SPT) Blows/0.3m (10 20 30 40)	Water Content (%) (10 20 30 40)
SILT – some fine grain sand, trace fine gravel, firm, dry, brown.	1 – 2	1-1	SS	●	
SAND – silty, fine grained, trace fine gravel, compact, dry, brown.	3 – 5	1-2	SS	●	
		1-3	SS	●	
SILT with fine grained sand layers, stiff to very stiff, damp, rusty-mottled.	6 – 8	1-4	SS	●	
		1-5	SS	●	
E.O.H. @ 8.2m	9 – 10				

Investigation Date: June 16, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: AL

SS – Split Spoon

G – Grab

Project: Okanagan Vistas

Location: 13610 Banks Crescent, Summerland

Test Hole: TH- 8

Client: Lark Group

RGC File No.: RGC – 1839

Elevation: 394.7m

SUBSURFACE PROFILE		SAMPLE		FIELD TEST	
Soil Description	Depth (metres)	Sample Number	Sample Type	Standard Penetration Test (spt) Blows/ft (10 20 30 40)	Water Content (%) (10 20 30 40)
GRAVEL & SAND – trace silt, loose, dry.					
SILT – trace clay and sand, compact, firm to stiff, dry to damp, grey	2	1-1	SS	•	
		1-2	SS	•	
SILT – hard, dry to damp, gray.	4	1-3	SS	•	
GRAVEL to small cobbles, some silt, sand, compact to dense, stiff, dry to damp, olive.	6	1-4	SS	•	
SAND –fine grained, uniform, compact, dry, brown	8	1-5	SS	•	
SILT – stiff, dry, brown.	10	1-6	SS	•	
		1-7	SS	•	
E.O.H. @ 11.3m	12				
	14				
	16				
	18				
	20				

Investigation Date: June 15, 2016

Subcontractor: Mud Bay Drilling

Equipment: Fraste XL3 Drill

Logged By: PG

SS – Split Spoon

G – Grab

ROCK GLEN CONSULTING LTD.
P.O. Box 36, Okanagan Falls, B.C. V0H 1R0
Tel: (250) 497-8290 Fax: (250) 497-8291
E-mail: rockglen@shaw.ca

October 13, 2016 RGC-1839

The Lark Group
Suite 1500, 13737 – 96 Avenue
Surrey, B.C. V3V 0C6
Attention: Malek Tawashy

Dear Mr. Tawashy:

Subject: Addendum to September 30, 2016 Geotechnical Assessment Report
Proposed Summerland Independent & Assisted Living Development
13610 Banks Crescent, Summerland

Further to our discussions today, RGC has prepared this addendum letter to clarify slope stability and slope setback requirements for this development that were presented in our September 30, 2016 report.

In this regard, the reference to a 2H:1V slope setback was to identify building locations that required further review to determine if they were situated on stable ground with a sufficient slope setback.

RGC has reviewed the latest proposed locations and elevations of Buildings C and E. As stated in the September 30, 2016 report, RGC's stability assessment confirms that all proposed building locations are currently situated on stable ground.

Notwithstanding that the proposed locations of the buildings are situated on stable ground with an adequate slope setback, RGC will provide geotechnical engineering review during construction of the proposed buildings to ensure that they are constructed in stable locations with respect to slope setbacks.

We trust that this is the clarification required regarding slope setbacks of buildings in the development. Please contact us with any additional questions.

Yours truly,

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
A. N. LECOMTE
43698

OCT 13 2016

Amber LeComte, P. Eng.
Rock Glen Consulting Ltd.

Reviewed and Approved by Paul Glen, P.Eng.

APPENDIX D: *LANDSLIDE ASSESSMENT ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia*", March 2006/Revised September 2008 ("*APEGBC Guidelines*") and the "2006 BC Building Code (BCBC 2006)" and is to be provided for *landslide assessments* (not floods or flood controls) for the purposes of the Land Title Act, Community Charter or the Local Government Act. Italicized words are defined in the *APEGBC Guidelines*

To: The *Approving Authority* Date: September 30, 2016

District of Summerland
13211 Henry Ave., Summerland

Jurisdiction and address

With reference to (check one):

- ☐ Land Title Act (Section 86) – Subdivision Approval
- ☒ Local Government Act (Sections 919.1 and 920) – Development Permit
- ☐ Community Charter (Section 56) – Building Permit
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Exemption
- ☐ British Columbia Building Code 2006 sentences 4.1.8.16 (8) and 9.4 4.4.(2) (Refer to BC Building and Safety Policy Branch Information Bulletin B10-01 issued January 18, 2010)

For the Property: 13610 Banks Crescent, Summerland

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist*.

I have signed, sealed and dated, and thereby certified, the attached *landslide assessment* report on the Property in accordance with the *APEGBC Guidelines*. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

✓ 1. Collected and reviewed appropriate background information
✓ 2. Reviewed the proposed *residential development* on the Property
✓ 3. Conducted field work on and, if required, beyond the Property
✓ 4. Reported on the results of the field work on and, if required, beyond the Property
✓ 5. Considered any changed conditions on and, if required, beyond the Property
6. For a *landslide hazard analysis* or *landslide risk analysis* I have:
   ✓ 6.1 reviewed and characterized, if appropriate, any *landslide* that may affect the Property
   ✓ 6.2 estimated the *landslide hazard*
   ✓ 6.3 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
   ✓ 6.4 estimated the potential *consequences* to those *elements at risk*
7. Where the *Approving Authority* has adopted a *level of landslide safety* I have:
   ___ 7.1 compared the *level of landslide safety* adopted by the *Approving Authority* with the findings of my investigation
   ___ 7.2 made a finding on the *level of landslide safety* on the Property based on the comparison
   ___ 7.3 made recommendations to reduce *landslide hazards* and/or *landslide risks*
8. Where the *Approving Authority* has not adopted a *level of landslide safety* I have:

✓ 8.1 described the method of *landslide hazard analysis* or *landslide risk analysis* used

✓ 8.2 referred to an appropriate and identified provincial, national or international guideline for *level of landslide safety*

✓ 8.3 compared this guideline with the findings of my investigation

✓ 8.4 made a finding on the *level of landslide safety* on the Property based on the comparison

✓ 8.5 made recommendations to reduce *landslide hazards* and/or *landslide risks*

___ 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparison between

Check one

☐ the findings from the investigation and the adopted *level of landslide safety* (item 7.2 above)

☑ the appropriate and identified provincial, national or international guideline for *level of landslide safety* (item 8.4 above)

I hereby give my assurance that, based on the conditions[1] contained in the attached *landslide assessment* report,

Check one

☐ for subdivision approval, as required by the Land Title Act (Section 86), "that the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☐ without any registered covenant.

☑ for a development permit, as required by the Local Government Act (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under [Section 920] subsection (7.1) it will impose in the permit".

☐ for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☐ without any registered covenant.

☐ for flood plain bylaw variance, as required by the "Flood Hazard Area Land Use Management Guidelines" associated with the Local Government Act (Section 910), "the development may occur safely".

☐ for flood plain bylaw exemption, as required by the Local Government Act (Section 910), "the land may be used safely for the use intended".

Paul Glen
Name (print)

Paul Glen
Signature

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
P. K. GLEN
22954

September 30, 2016
Date

[1] When seismic slope stability assessments are involved, *level of landslide safety* is considered to be a "life safety" criteria as described in the National Building Code of Canada (NBCC 2005), Commentary on Design for Seismic Effects in the User's Guide. Structural Commentaries, Part 4 of Division B. This states:

"The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse nor will its attachments break off and fall on people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse".

Box 36 V0H 1R0
Address
Okanagan Falls, BC
250 497-8290
Telephone

(Affix Professional seal here)

If the *Qualified Professional* is a member of a firm, complete the following

I am a member of the firm Rock Glen Consulting Ltd.
and I sign this letter on behalf of the firm. (Print name of firm)

GEOPACIFIC
VANCOUVER KAMLOOPS CALGARY

P 604.439.0922
F 604.429.9189
geopacific.ca
1779 W 75th Ave.
Vancouver, B.C. Canada V6P 6P2

Lark Group
Suite 1500, 13737 96th Avenue
Surrey, B.C.
V3V 0C6

June 30, 2017
File: 15164

Attention: Jack Bray

Re: Geotechnical Review of Potential Groundwater Impacts: Proposed ICASA Resort Living Development, 13610 Banks Crescent, Summerland, B.C.

You have asked the writer to provide an opinion on the likely impacts of the proposed development on a local aquifer that provides fresh water for an adjacent fish hatchery located east of the site near Okanagan Lake. The new development proposed consisting of residential units over buried parking levels. There is parking on 4 levels however the levels are stepped to accommodate the slopes on site and it is understood that the excavation depth is limited to 11 m or less, below current site grades, with generally decreasing excavation depths towards the east where grades are lower.

You have provided us with deep test holes from a geotechnical report, prepared by Rock Glen Consulting Ltd. and dated September 30, 2016 for our reference. The test holes show the site to be underlain by a mixture of well graded till like silt with some sand and gravel and more recent lacustrine silt, described as stiff to very stiff. The lacustrine silt is strong and know to form steep cliffs in the area. The deep test holes drilled on the property identified groundwater at depths of 27 to 35 m, within a zone of gravel to sand and gravel (aquifer). Above the aquifer, soils are predominantly silt and dense or stiff so that vertical permeability is expected to be very low.

Groundwater is not expected to be encountered during the excavation and construction phase. Any surface water will managed in accordance with the Construction Erosion and Sedimentation Control Plan prepared by CTQ. Given the depth of the groundwater and the fact that it is within a confined aquifer that has no hydraulic connectivity with the dense to stiff silt above 25 m depth at the site, we do not expect any impacts on either the quality or quantity of groundwater available from the underlying aquifer as a result of the development.

Should you require any additional information or clarification of the foregoing please contact the undersigned.

For:
GeoPacific Consultants Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M. J. KOKAN
21364

JUL 10 2017

Matt Kokan, M.A.Sc., P.Eng.
Principal

ROCK GLEN CONSULTING LTD.
P.O. Box 36, Okanagan Falls, BC V0H 1R0
Tel: (250) 497-8290, Fax: (250) 497-8291
rockglen@shaw.ca

August 3, 2017

Lark Group
Suite 1500, 13737 96th Avenue
Surrey, BC
V3V 0C6

Our File: RGC-1839

Attention: Myron Dirks

Subject: Geotechnical Engineering Review of Potential Groundwater Impacts: Proposed ICASA Resort Living Development 13610 Banks Crescent, Summerland, BC

Dear Mr. Dirks:

In response to your request, we are presenting our professional opinion on the potential impacts to the Shaughnessy Spring of proposed construction at 13610 Banks Crescent.

Rock Glen Consulting is retained as the geotechnical engineers for this project. As such, we have been involved in site investigations and review of construction plans for the project. We are well informed regarding the potential impacts of construction on the underlying aquifer.

Test pit excavations and test drilling did not encounter groundwater within planned construction depths. Soils associated with planned excavations and building construction include typical Okanagan glaciolacustrine silts as well as fluvial sands and gravels.

Our experience indicates that potential issues of concern are: slope stability, construction vibrations, and stormwater management.

Slope stability issues will be managed with conventional geotechnical construction methodologies. Construction excavation stability will be undertaken by experienced contractors under the direction of qualified geotechnical engineers.

Temporary excavation slopes will be designed and monitored to protect workers on the site, and also to ensure the long-term stability of those slopes once the construction is completed and all the buildings are backfilled. Proper drainage around those buildings for the foundations will ensure ongoing stability as well.

Slope stability outside of building areas will be monitored as construction proceeds and setbacks for construction of roadways, buildings, and other structures on the sites will ensure that the

construction activities do not contribute to changes in the stability of those slopes. In particular, sufficient setbacks and runoff erosion protection measures will be implemented to maintain a low risk of any slope instability issues in the area above the Shaughnessy Spring.

Excess water into the ground on a project such as this is normally associated with stormwater runoff from roof areas, parking areas, and other hard surfaces on the site. Stormwater runoff will be managed by following the Construction Erosion and Sedimentation Control Plan prepared by CTQ. Stormwater runoff will be collected for discharge offsite to eliminate the potential for onsite disposal of stormwater runoff having an impact on either buildings or the underlying aquifer.

Vibrations during construction include vibrations from excavation, backfilling and foundation preparation activities. Vibrations from excavation work are typically minimal – some of the soil materials and the gravels will create vibrations of a minor nature as they are excavated and these will attenuate at shallow depths in the surrounding soil.

Requirements for structural fill either as foundations under buildings, structural backfill behind retaining walls or building foundations as well as sub-base and base course materials for roadways will be vibratory-packed and these activities will also generate vibrations. The attenuation of these vibrations from even the largest vibratory compactors is expected to attenuate within 5-10 m below where the compaction effort is being applied. On this site, that is estimated to be a maximum of 12 to 15 m below the current ground surface.

RGC is satisfied that the vibrations generated by the excavation and compaction work required to construct the ICASA Resort Living Development will not impact the underlying aquifer, and that the CTQ surface water management plan provides assurance that stormwater runoff from the ICASA site will also not impact the underlying aquifer.

Further, both short-term and long-term slope stability will be managed by adequate setbacks from slopes, including those above the Shaughnessy Spring area, and through construction monitoring by qualified profession engineers.

RGC is confident that construction and operation of the ICASA Resort Living Development represents a very low risk to the aquifer underlying the site and to the water discharged from the Shaughnessy Spring.

Sincerely,

Aug. 3, 2017

Paul Glen, P. Eng.
Rock Glen Consulting Ltd.

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Propagation and attenuation characteristics of various ground vibrations

Dong-Soo Kim[a,*], Jin-Sun Lee[1,a]

[a]*Department of Civil Engineering, Korea Advanced Institute of Science and Technology, Taejon, 305-701, South Korea*

Accepted 27 December 1999

Abstract

In order to effectively control vibration related problems, the development of a reliable vibration monitoring system and the proper assessment of attenuation characteristics of various vibrations are essential. Various ground vibrations caused by train loading, blasting, friction pile driving and hydraulic hammer compaction were measured using 3D geophones inside of the borehole as well as on the ground surface, and the propagation and attenuation characteristics of various source generated vibrations were investigated by analyzing particle motions. For the geometric modeling of various vibrations, the types of various sources and their induced waves were characterized and the geometric damping coefficients were determined. The measured attenuation data matched well with the predicted data when using the suggested geometric damping coefficient, and the estimated soil damping ratios were quite reasonable taking soil type of the site and experiencing strain level into consideration.

Keywords: Ground vibration; Attenuation characteristics; Geometric damping; Material damping; Particle motions; Train loading; Blasting; Pile driving; Hydraulic hammer compaction

1. Introduction

Vibrations from construction activities and traffic loading are important because they may cause damage to the adjacent structures as well as complaints to the neighbors. Damage of structures may be caused by the vibration induced differential settlement as well as by vibrations transmitted directly to structures [1–3]. Complexity of these vibrations related problems makes it difficult to identify the causes of damages. For the analysis of vibration related problems, it is necessary to consider the combined effect of several factors such as the characteristics of vibration sources, the site characteristics, the propagation of surface and body waves in the ground, and response of structures [4].

The environmental zone, which is effective to reduce the ground vibration amplitude, is often adopted to prevent the vibration damages. However, it is difficult to estimate to what degree the amplitude of vibration decreases at a certain distance. Generally, the attenuation of vibrations with distance is composed of two factors: geometric damping and material damping. The geometric damping depends on the type and the location of vibration source and the material damping is related with ground properties and vibration amplitude [5].

Most of ground vibrations are currently measured only at the ground surface, not in-depth, without considering the propagation path. Propagation characteristics of vibrations generated by various sources may be dependent on the type of the generated waves, which can be assessed by measuring particle motions in three directions including vertical, longitudinal, and transverse directions. The three directional particle motion monitoring on the ground surface and in-depth is important for the characterization of propagating waves [6].

In this study, the ground vibrations induced by train loading, blasting, friction pile driving, and hydraulic hammer compaction were measured by using 3-component (3D) geophones, which can monitor both surface and in-depth vibrations. By analyzing the measured particle motions and major energy component in the frequency domain, the propagating waves generated by each vibration source was characterized. Finally, attenuation characteristics of vibration sources were investigated considering the source characteristics and the geotechnical properties of the sites.

2. Calibration and development of 3D geophone

For a reliable in-situ vibration measurement, it is the first step to calibrate a vibration monitoring transducer. The

* Corresponding author. Tel.: + 82-42-869-3619; fax: + 82-42-869-3610.

E-mail addresses: dskim@cais.kaist.ac.kr (D.-S. Kim); blueguy@bomun.kaist.ac.kr (J.-S. Lee).

[1] Tel.: + 82-42-869-5659; fax: + 82-42-869-3610.

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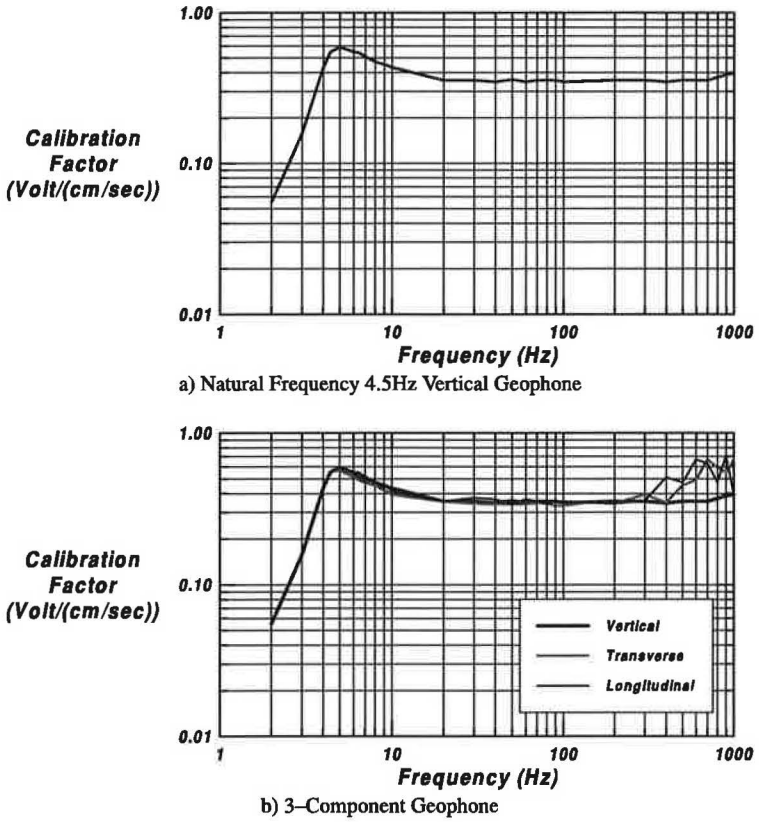

Fig. 1. Calibration curve for 4.5 Hz geophone and 3-component geophone: (a) Natural frequency 4.5 Hz vertical geophone; and (b) 3-component geophone.

velocity transducer, which usually is called geophone, is widely used for ground vibration measurement. The response of velocity transducer becomes nonlinear at low frequencies and has a natural frequency since it is a single-degree-of-freedom system. It is, therefore, necessary to calibrate exact voltage output of the geophone with frequency [7]. Typical calibration curve for the geophone (with open shunt damping) which has a natural frequency of 4.5 Hz is presented in Fig. 1a. Calibration factor is constant in frequencies approximately ranging from 10 to 500 Hz, representing the reliable range of vibration measurement using this transducer. For the vibration measurements at low frequencies below 10 Hz, the 2 Hz geophone (Mark Product L-4) was used with a factory calibration chart.

To characterize the vibrations induced by various sources, it is essential to measure the 3D particle motions. Vibrations are required to be monitored in-depth as well as on the ground surface because some vibration sources such as blasting and pile driving are located at a certain depth below ground. In case of the in-depth vibration measurements, proper orientation and coupling of each transducer in the ground should be secured for the reliable measurements. In this study, 3D-vibration measurement system (3D geophone) was developed by molding three well-calibrated geophones in the aluminum casing in the vertical, longitudinal, and transverse directions. For the in-depth vibration measurements, the 3D geophone can be tightly attached to the borehole at a given depth by inflating a rubber pad, and the direction of each transducer can be confirmed on the ground surface by checking the direction of the orientation rod. The typical frequency responses of the 3D geophone is shown in Fig. 1b, indicating that the vibration measurement can be reliably performed at frequencies ranging from 10 to 200 Hz.

3. Measurement of various ground vibrations

Ground vibrations generated by various sources such as train loading, in-depth blasting, friction pile driving and hydraulic hammer compaction were monitored using the 4.5 and 2 Hz vertical geophones and 3D geophones. The amplitudes in time and frequency domains are analyzed for various ground vibrations.

3.1. Train loading

Monitoring of the ground vibration generated by train loading was performed at the Byung-Jum station in Kyung-Bu railroad using the six calibrated 4.5 Hz vertical geophones and two 3D geophones. The site was composed of 15 m deep residual sandy silt or silty sand layer over weathered rock (Fig. 2a). The locations and spacing of geophones are shown in Fig. 2b. Totally 17 measurements were performed on the ground surface.

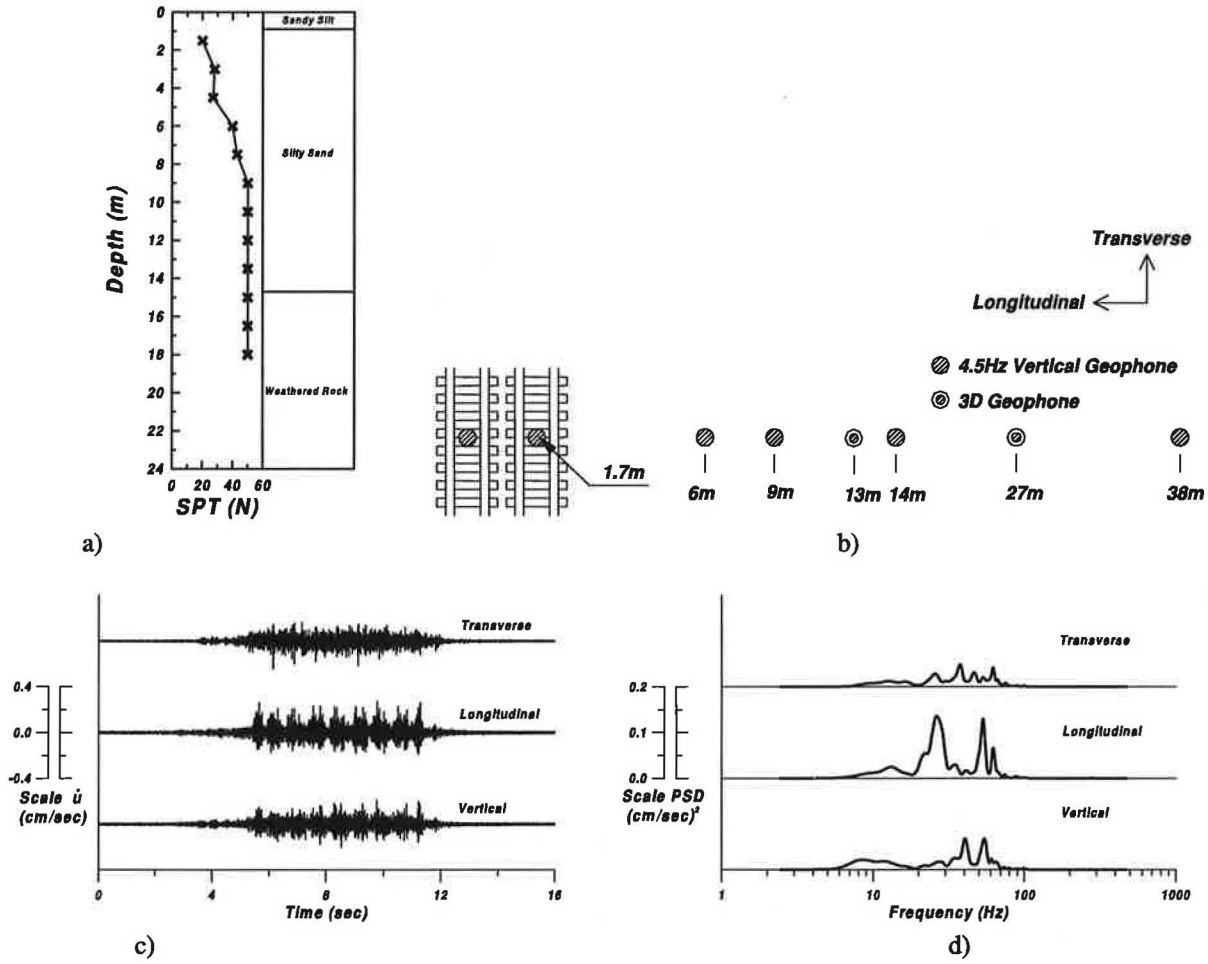

Fig. 2. Site information, typical 3-component time records and power spectral density induced by train. (No. of passenger cars: 8; train speed: 125 km/h; recorded at 13 m apart from sleeper.)

The vibration amplitude measured on the adjacent ground was reduced to about 2 cm/s due to the effect of ballast whereas the amplitude on the sleeper was about 10 cm/s. The vibration amplitude usually increases as increasing the train speed. Typical time domain signals measured using 3D geophone located 13 m apart from the sleeper are shown in Fig. 2c. The energy generated by train induced vibration exist in all three directions almost evenly.

The dominant frequency ranges induced by train loading can be represented by the sleeper passing frequency and the wheel passing frequency [8]. As shown in Fig. 2d, the train induced frequency measured on the ground was widely distributed in the ranges from 7 to 70 Hz. The dominant frequency range varies a little depending on the train speed.

3.2. Blasting

Test blasting before major tunnel construction for high-speed railroad was performed and blasting induced vibrations were measured at Taejon. The test site was composed of 12 m depth fill and weathered soil layer over weathered rock (Fig. 3a). Blasting was performed inside the bedrock at depths of about 28–44 m using $1 \sim 3$ kg charge weight. Vibrations were measured in-depth as well as on the ground using three 4.5 Hz vertical geophones and two 3D geophones as shown in Fig. 3b. The peak particle velocity varies significantly due to the charge weights and the measured value at a horizontal distance of about 32 m was in the range from 1.5 to 2.5 cm/s.

Typical time domain signals measured by a 3D geophone at a depth of 7.5 m are presented in Fig. 3c. Depending on the orientations of transducers, either P or S wave energy was dominant: in the longitudinal and vertical direction the P wave was dominant whereas S wave energy was bigger in the transverse directions. Vibration amplitude was a little bigger in the vertical and longitudinal direction than in the transverse direction. Most of the energy in the blasting induced vibration exists at frequencies below about 50 Hz, and the spectrum energy in the longitudinal direction was larger than others as shown in Fig. 3d.

3.3. Friction pile driving

Vibrations caused by friction pile driving were measured

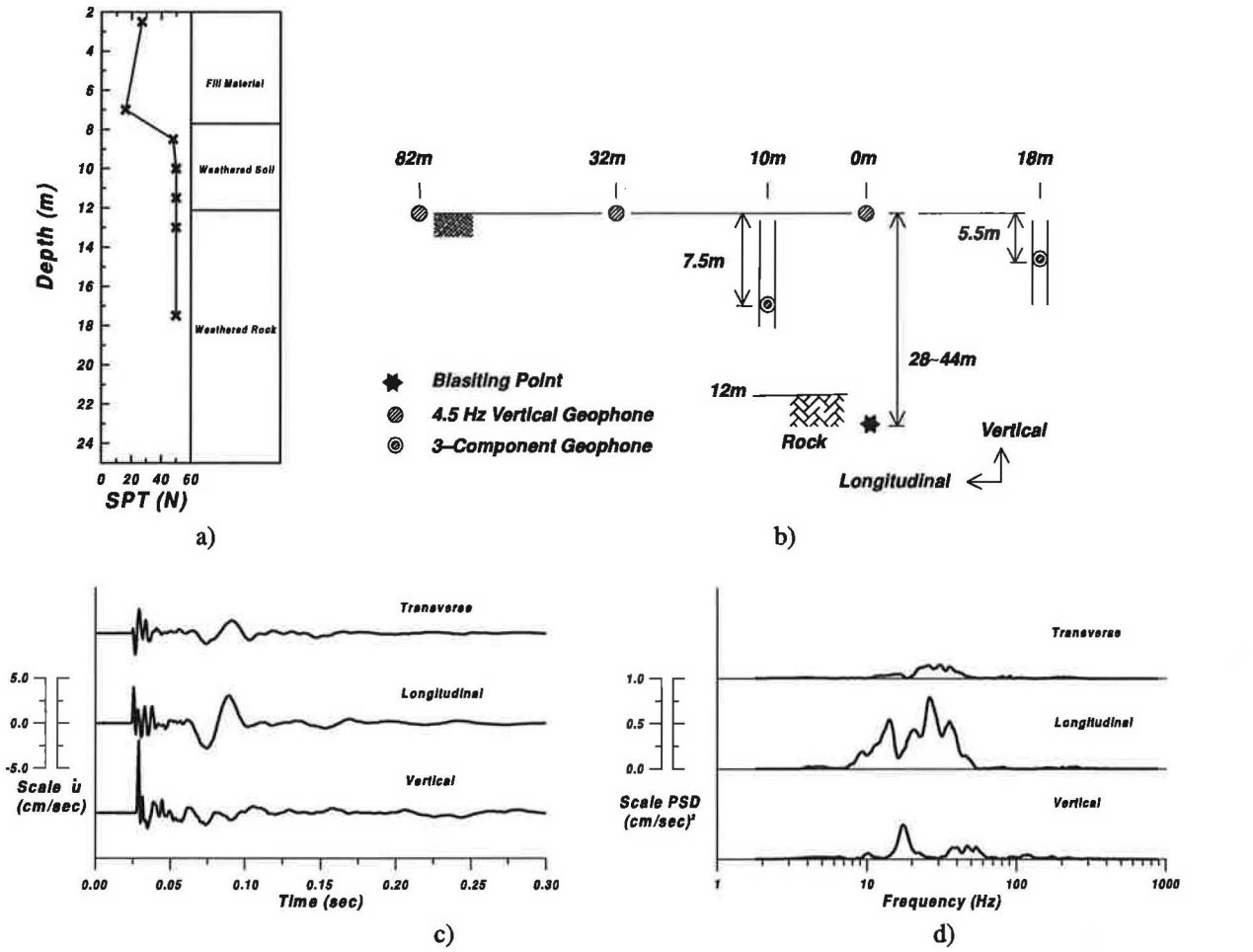

Fig. 3. Site information, typical 3-component time records and power spectral density induced by in-depth blasting. (Charge weight: 2 kg TNT; depth of explosion: 28 m, recorded at distance 10 m, 7.5 m, horizontal and depth, respectively.)

at a long-span bridge pier construction site located at Pusan. The steel pipe pile (diameter of 0.6 m) was driven to the depth of about 40 m using hydraulic hammer with a hammer weight of 7 t and a drop height of 0.8 m. The site was composed of 15 m of gravel fill, interbedded medium silty sand and clay layers of about 20 m, sand layer 5 m, weathered residual soil layer of 7 m and bedrock (Fig. 4a). During driving at tip depths of 16 ~ 28 m, vibrations were measured using three 4.5 Hz vertical geophones and two 3D geophones as shown in Fig. 4b.

The peak particle velocity decreases as increasing the depth to the pile tip and the amplitude measured on the ground surface at a distance of about 7 m ranges from 0.15 to 0.5 cm/s. Typical time and frequency domain signals measured by a 3D geophone at a depth of 15 m are presented in Fig. 4c and d. Most of the energy in the friction pile induced vibration was transmitted by vertical motion with frequencies below about 10 Hz except transverse motion. At a given horizontal distance, the magnitudes of vertical particle motions measured on the ground surface and at depth of 15 m were almost identical. It appears that friction pile driving tries to overcome the friction mobilized between soil and pile shaft, and during this process a whole mass of soil layer vibrates at low frequencies.

3.4. Hydraulic hammer compaction

Hydraulic hammer compaction was performed at Yongjong Island where Inchon International Airport being constructed. The site consisted of a reclaimed soil of about 6 m and a weak alluvial clayey silt layer of about 20 m and an alluvial stiff silty clay layer of about 15 m, residual sandy soil and bed rock (Fig. 5a). The reclaimed layer, classified as SM, was required to be improved to build a pavement structures for run way, taxiway and apron. The hydraulic hammer compaction with a tamper of 10 t and a drop height of 1.2 m was employed to improve the reclaimed layer minimizing the size of the disturbed craters. Vibrations were measured using four 2 Hz vertical geophones and two 3D geophones as shown in Fig. 5b.

The peak particle velocity measured at distances about of 10–100 m ranges from 0.1 to 4 cm/s. Typical time domain signals monitored on the ground surface by using 3D geophone are shown in Fig. 5c. The vibration amplitude

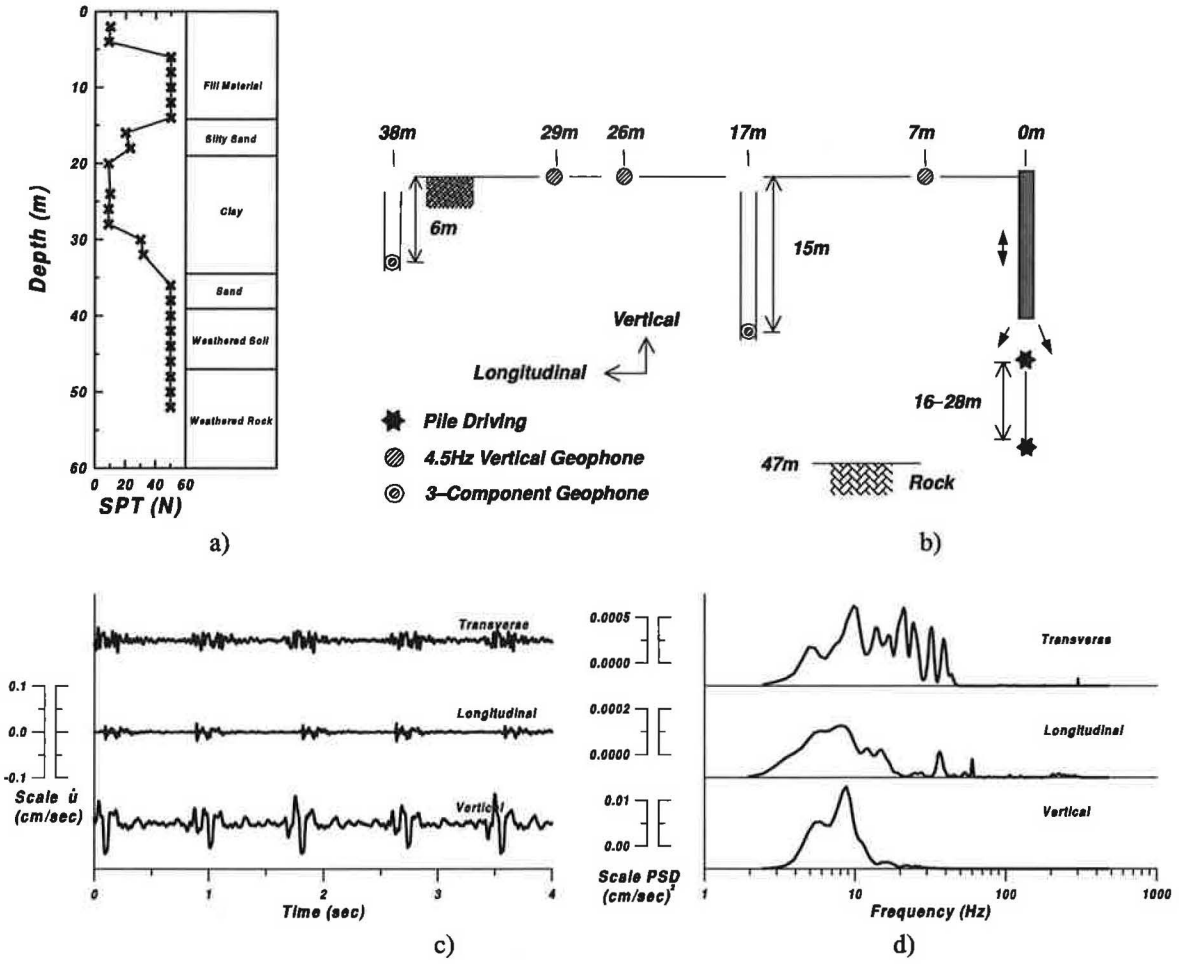

Fig. 4. Site information, typical 3-component time records and power spectral density induced by friction pile driving. (Depth of pile tip: 17 m; recorded at distance 17 m, 15 m, horizontal and depth, respectively.)

in the vertical direction was largest and the amplitudes in the longitudinal and transverse directions were about 75 and 35% of the vertical amplitude, respectively. The most of the energy induced by compaction exists in frequencies of 3–10 Hz for the vertical and longitudinal motions, and some energy exists above 10 Hz for the transverse motion (Fig. 5d).

4. Propagation and attenuation of various ground vibrations

Propagation characteristics of vibrations generated by various vibration sources may be dependent on the type of the generated waves which can be assessed by measuring particle motions. Vibration amplitude is reduced during their propagation through the ground because of geometric and material dampings. To therefore effectively control the vibration related problems, the investigations of propagation and attenuation characteristics are required.

4.1. Theoretical background of vibration attenuation

Vibrations lose energy during propagating in the ground and the amplitude of the vibrations decreases with increasing distance from the source. The decay of amplitude of vibration with distance can be attributed to two components; geometric (radiation) damping and material damping, which may be described by the following equation [9]

$$w_2 = w_1\left(\frac{r_1}{r_2}\right)^n e^{-\alpha(r_2-r_1)} \quad (1)$$

where, w_1 and w_2 are vibration amplitudes at distance r_1 and r_2 from a source of vibration; n is a geometric damping coefficient; α is a material damping coefficient.

The geometric damping occurs due to the decrease of the energy density with distance from source. Geometric damping coefficient can be analytically determined by assessing the type of the propagating wave, source type and location as shown in Table 1 [10]. Geometric damping occurs even in a perfectly elastic media.

Meanwhile, the ground is not perfectly elastic and the

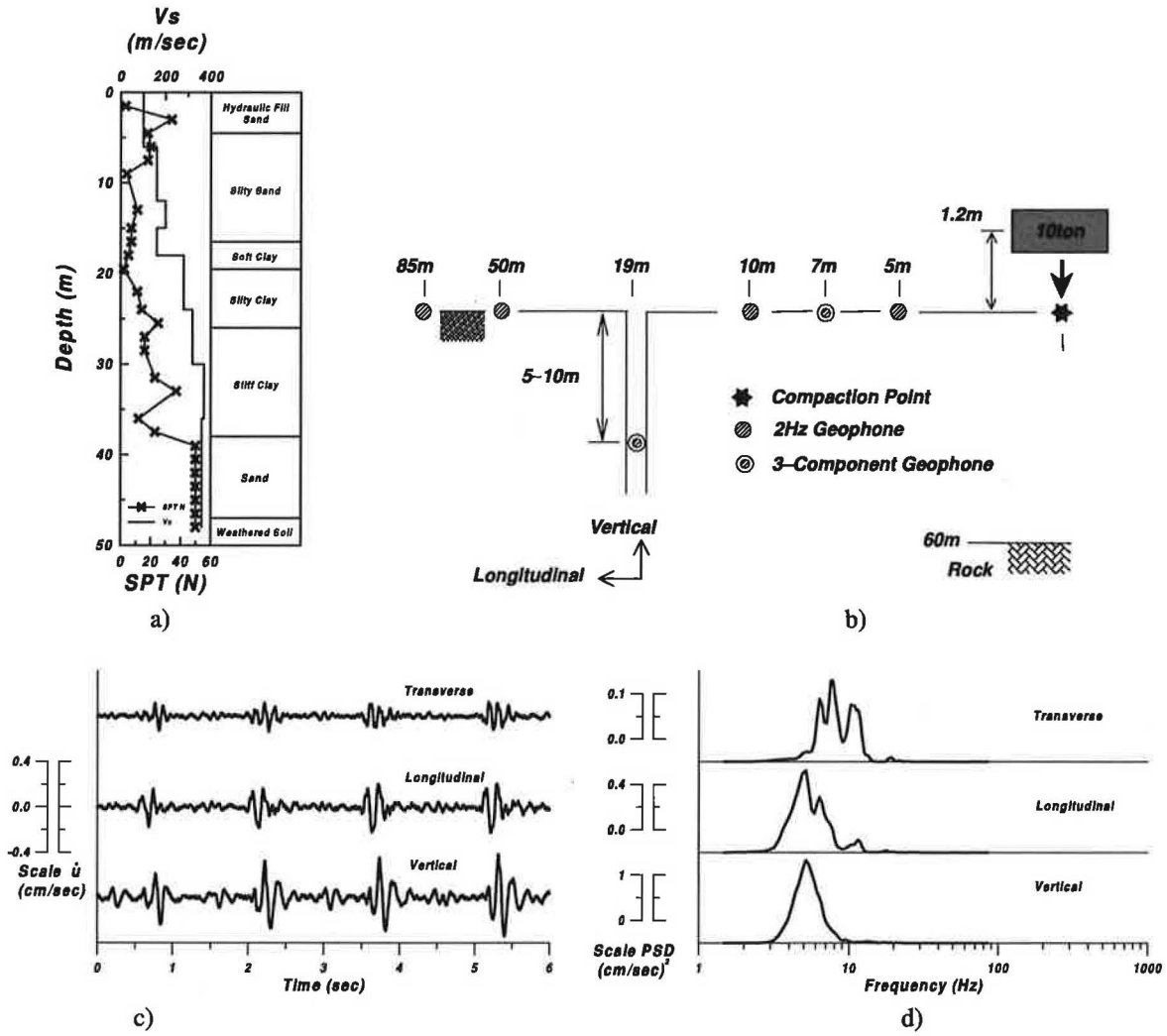

Fig. 5. Site information, typical 3-component time records and power spectral density induced by hydraulic hammer compaction. (Recorded at horizontal distance 7 m.)

vibration energy is reduced due to the friction and cohesion between soil particles. This attenuation due to material damping is affected by the soil type and frequency of vibration. Material damping coefficient, α, can be represented as:

$$\alpha = \frac{\pi \eta f}{c} \tag{2}$$

where η is a loss factor, f is a frequency of the wave and c is the propagation velocity of the wave. Woods and Jedele [5] classified the site soils into four classes ranging from sound, hard rock to weak and soft soils. The loss factor is related with the hystertic damping ratio of the ground. Because the damping ratio is constant and minimum below the elastic threshold strain and then increases with increasing strain

Table 1
Geometric damping coefficients for various sources [10]

Physical sources	Type of source	Wave	Location	n
Highway/Rail line footing array	Line	Surface	Surface	0
		Body	Surface	1.0
Car in pothole, Single footing	Point	Rayleigh	Surface	0.5
		Body	Surface	2.0
Tunnel	Buried Line	Body	Interior	0.5
Buried explosion	Buried point	Body	Interior	1.0

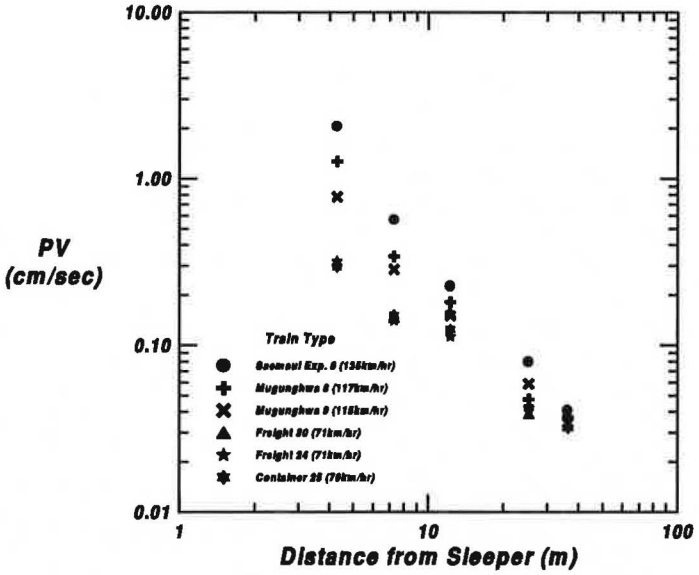

Fig. 6. Attenuation characteristics with distance of various train loading.

amplitude [11], the material damping coefficient is also affected by the strain amplitude of ground experiencing by propagating vibrations, which can be expressed by the following equation:

$$\gamma = \frac{\dot{u}}{v_s} \tag{3}$$

where γ is shear strain, $\dot{u}$ is particle velocity and v_s is shear wave velocity.

4.2. Propagation and attenuation characteristics of train induced vibration

The train induced vibration is generated by moving load. The vibration measured at a certain distance from the rail is a superposed signal of various vibrations occurred at different locations with different phases. These characteristics affect the propagation and attenuation characteristics of train induced vibrations. The variations in vibration amplitude with distance for various types of trains are shown in Fig. 6. It is interesting to note that the speed and length of train affect the vibration amplitude and the rate of attenuation.

Gutowski and Dym [10] have mentioned that a train can be modeled as a line source if the distance of the receiver is less than $1/\pi$ times the source length, and the major energy is transmitted in Rayleigh wave form with no geometric damping. In this study, the length of train ranges from 130 to 450 m and the distance to the farthest receiver is 38 m, which exists within $1/\pi$ times the source length. The measured attenuation rate in Fig. 6 was far greater compared with their reasoning.

In order to assess the characteristics of propagating wave, variation in particle motion with time history was detected using the recorded data from the 3D geophone. As shown in Fig. 7, train induced vibration was mainly composed of Rayleigh wave with elliptic counter-clockwise motion. However, significant amount of horizontal shear wave energy portion was shown in vertical–transverse plane. The train induced vibration was found to contain 3-directional motions almost evenly, and can be characterized as a mixture of body and surface waves. Therefore, it is hard to

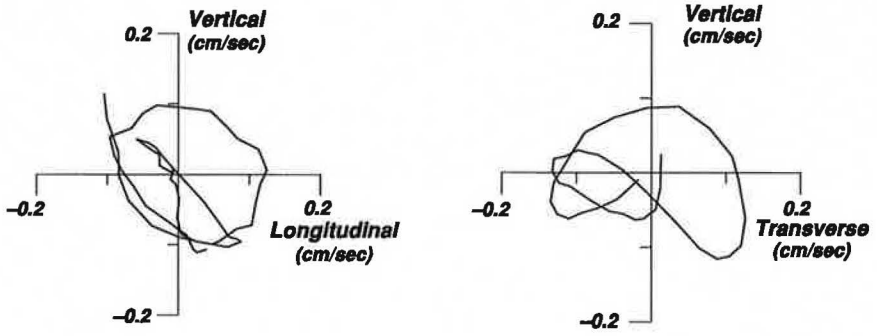

Fig. 7. Particle motion of train induced vibration.

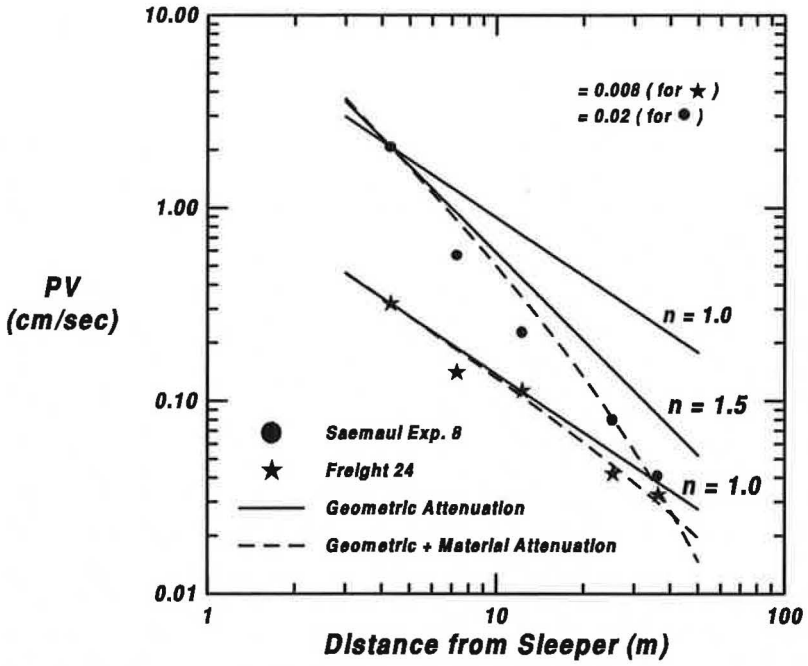

Fig. 8. Attenuation with distance of train induced vibration.

select the geometric attenuation coefficient of train induced ground vibration, and Verhas [12] has introduced a superposed attenuation model. But the superposed model was too site specific and the resulting material damping ratio of soil was about 5–7% which was relatively high where the soil undergoes linear deformation ranges.

In order to investigate the effects of the speed and length of train on the attenuation characteristics, the variations in vibration amplitude with distance are plotted in Fig. 8 for two cases: (i) a saemaul express train of 8 cars with a speed of 135 km/h; and (ii) a freight train of 24 cars with a speed of 71 km/h. Ground vibration induced by shorter and faster train was attenuated faster than that of longer and slower train. Due to the superposition effect of moving load, train loading of the shorter and faster train can be characterized as a combination of the point and the line sources of body wave with a geometric damping coefficient of 1.5. If this loading was classified as a point source, the geometric attenuation would be larger than measured attenuation, whereas if classified as a line source, the material damping would be unreasonably high. For the longer and slower train, it can be characterized as a line source of body wave with a geometric damping coefficient of 1.0. The material damping coefficients of the site of the faster train and the slower train were evaluated as 0.02 and 0.008 (1/m), respectively. The corresponding damping ratio and the maximum strain amplitude were 2.3 and 0.01% for the faster train, and 0.9 and 2×10^{-3}% for the slower train. The calculated damping ratio was reasonable considering the soil type and the experiencing strain amplitude. If the train induced vibrations were classified as Rayleigh wave, the corresponding soil damping ratio to meet the attenuation characteristics should be unrealistically high.

4.3. Propagation and attenuation characteristics of blasting induced vibration

Ground vibration generated by in-depth blasting propagates

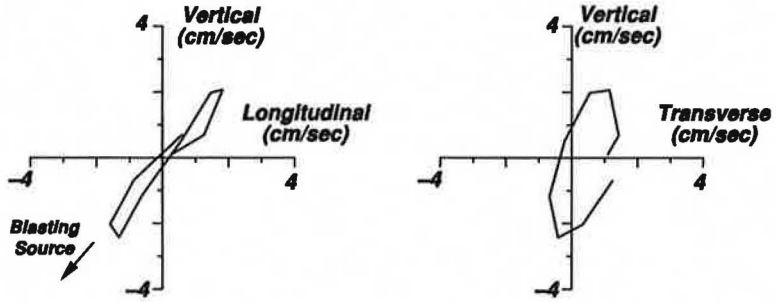

Fig. 9. Particle motion of in-depth blasting induced vibration.

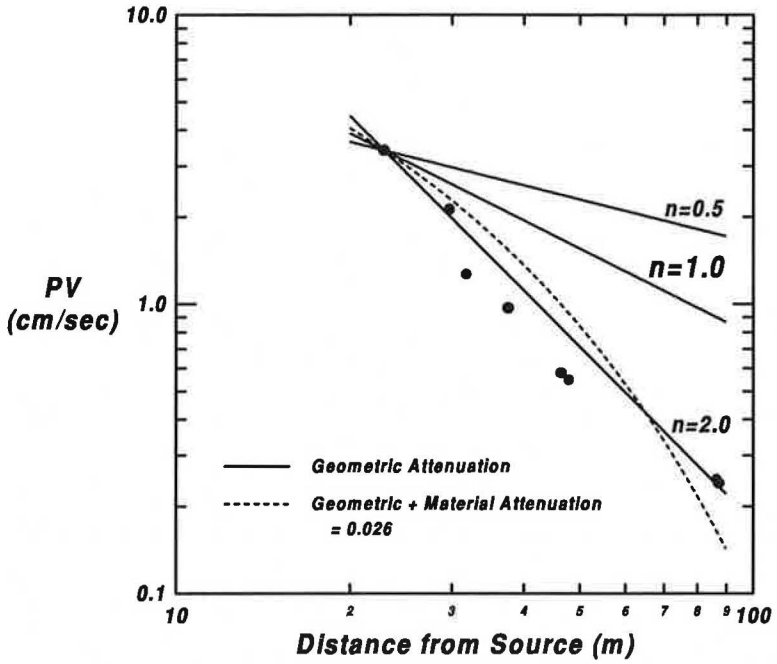

Fig. 10. Attenuation with distance of in-depth blasting induced vibration.

through rock or soil layer. If the layer is composed of several different types of soil, the transmission path of the blasting vibration is very complicated because of the reflection and refraction of the waves. In order to evaluate the major energy component of blasting induced vibration, the variations in particle motions in the vertical–longitudinal and vertical–transverse planes are plotted in Fig. 9. It can be clearly noticed that the compression wave components in the direction of source to receiver arrived dominantly. Therefore, blasting can be classified as an in-depth point source, which generates the P-waves and the propagation distance can be estimated as a distance from the source with a spherical wavefront. Typical variation in particle velocity of blasting induced vibration with distance is shown in Fig. 10. The measured attenuation data matched well with the geometric damping coefficient of 1.0 which represents body wave generated by the in-depth point source and the material damping coefficient of 0.026 (1/m). The corresponding damping ratio was 4–5% which was reasonable at a maximum strain amplitude of about 0.01% where the site soil experienced.

4.4. Propagation and attenuation characteristics of friction pile driving

It is generally considered that waves emanating from source such as a pile in the ground will include elastic waves in the form of compression waves, shear wave, and surface waves. Compression waves are considered to propagate from the area of the pile toe, expanding outwards over a spherical wavefront with a geometric damping coefficient of 1.0. The vertical shear waves emanates from shaft friction and expanding around a conical surface [13]. These concepts are shown in Fig. 11.

The variations in particle motions with time are shown in Fig. 12. Particle motions are mostly in the vertical direction,

Table 2
Geometric damping coefficients for various sources used in this study

Vibration sources used in this study	Location/Type of source	Induced wave type	n
Short length and high speed train	Surface/Combination of point and infinite line	Body wave	1.5
Hydraulic compaction	Surface/Point	Surface wave	0.5
Long length and slow speed train	Surface/Infinite line	Body wave	1.0
In-depth blasting friction pile driving	In-depth/Point	Body wave	1.0

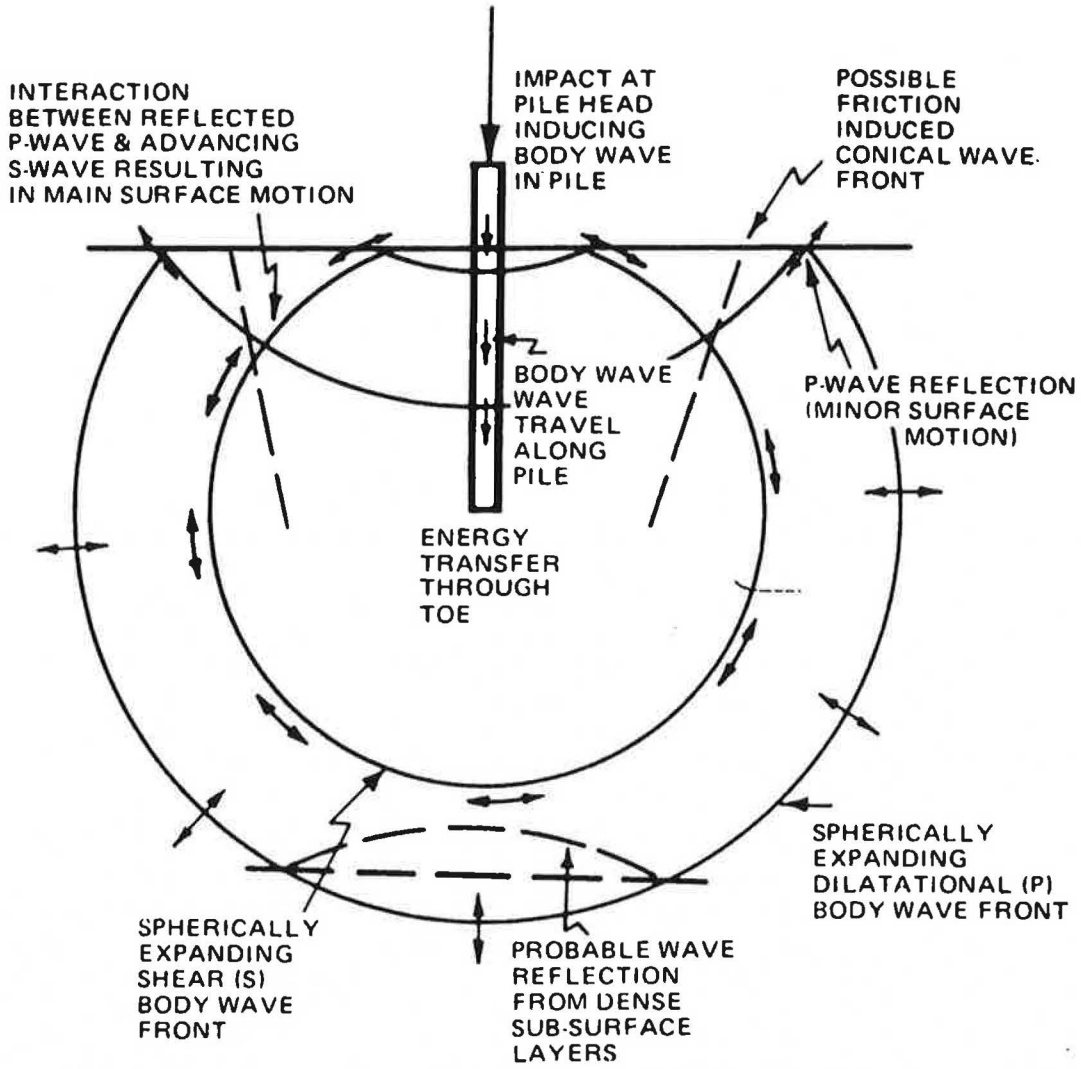

Fig. 11. Possible wavefronts from a driven pile [13].

and vibrations generated by friction pile driving can be characterized as a vertical shear wave with a conical wavefront. Therefore, the source can be classified as a point source generating body wave and the travel distance can be estimated as a horizontal distance from the source. Typical attenuation characteristics of the vibrations generated by friction pile driving are shown in Fig. 13. Using the geometric damping coefficient of 1.0 representing the in-depth point source, the measured characteristics matched well with the α value of 0.026 and the corresponding damping ratio of the site is 5–6% which is a little high at a maximum strain amplitude of about 0.001%. With the

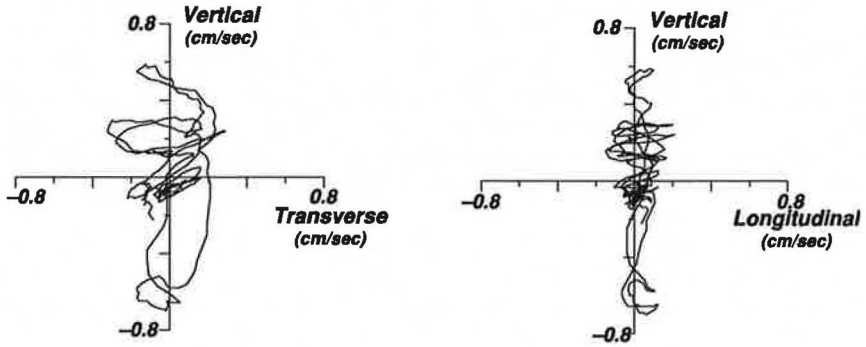

Fig. 12. Particle motion of friction pile driving induced vibration.

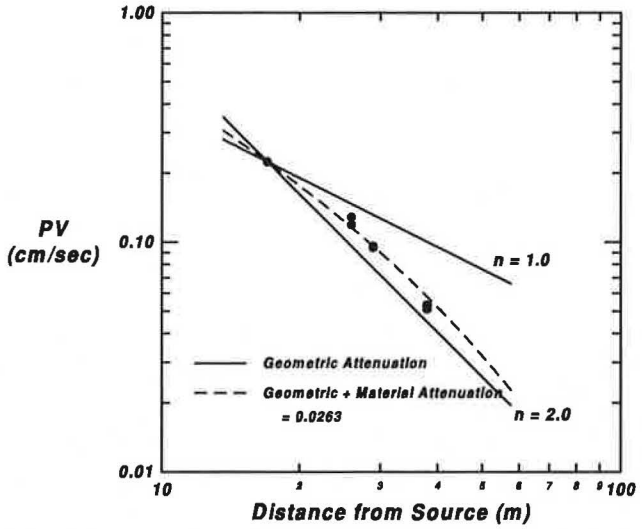

Fig. 13. Attenuation with distance of friction pile driving induced vibration.

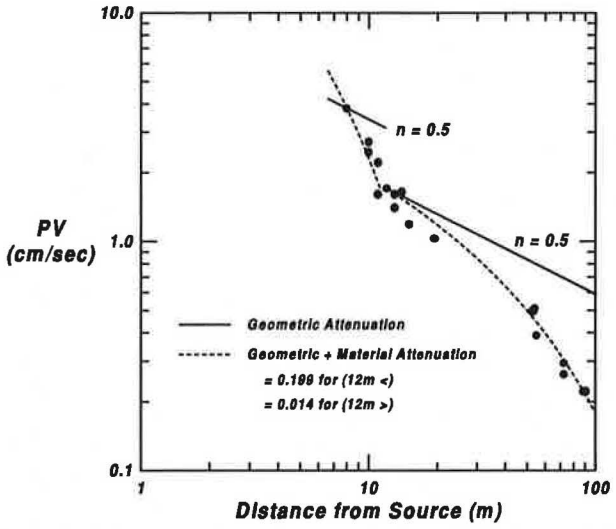

Fig. 15. Attenuation with distance of hydraulic compaction induced vibration.

geometric damping coefficient of 2.0 representing the surface point source, geometric damping exceed actual attenuation data.

4.5. Propagation and attenuation characteristics of hydraulic hammer compaction

The hydraulic hammer compaction, which is similar to vertically vibrating footing may generate both the body waves with a hemispherical wave front and the surface wave with a cylindrical wave front. [14]. The particle motions plotted in the vertical–longitudinal and vertical–transverse planes indicates that the major vibrating energy is transmitted by the surface wave with a retrograde ellipse particle motion (Fig. 14). The source can be classified as a surface point source generating surface wave and the travel distance can be estimated as a surface horizontal distance from the source.

The typical attenuation of particle motion with distance is shown in Fig. 15. The attenuation characteristics were predicted by using the geometric damping coefficient of 0.5, which is for the case of a surface point source generating the surface wave. The corresponding α values can be estimated separately as 0.199 in the near field within 12 m and 0.014 in the far field beyond 12 m. The wavelength of the propagation wave is about 12 m. The corresponding damping ratio in the near field was about 40% at the strain amplitude of 0.05% and the damping ratio in the far field was about 3% at strain amplitude of about 0.004%. Taking the soil type of the site and the experiencing strain level into consideration, the estimated damping ratios in the far field is reasonable, but the damping ratio in the near field is quite high. In the near field within the distance of one wavelength, body wave energy is significant and cannot be ignored in the estimation of geometric attenuation coefficient [15]. Therefore, the reason of high damping ratio can be explained by the body wave propagation in the near field which did not counted in the estimation of geometric attenuation coefficient.

5. Conclusions

Propagation and attenuation characteristics of various

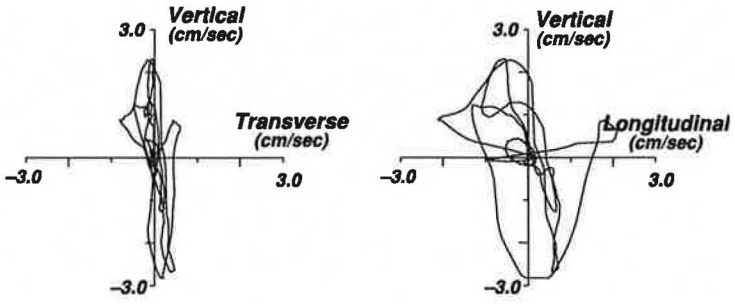

Fig. 14. Particle motion of hydraulic compaction induced vibration.

vibrations generated by train loading, blasting, friction pile driving, and hydraulic hammer compaction were investigated and the following conclusions can be drawn for this study.

1. Monitoring of particle motions using 3D geophones inside of the borehole as well as on the ground surface was effective to determine the propagation path and the type of major waves generated by various sources.
2. The train induced vibration was a mixture of body and surface waves and the primary energy of blasting induced vibration was transmitted by a compression wave. Friction pile driving provides a dominant vertical shear wave with a conical wave front and for a hydraulic hammer compaction major energy is transmitted by the surface wave with a retrograde elliptic particle motion.
3. For the geometric modeling of various vibrations, the types of source and induced wave are required to characterize. Train loading can be modeled as either a point or a line source depending on its length and speed which generating body wave. The in-depth blasting can be modeled as a body wave generating point source, the friction pile driving as a body wave generating point source, and hydraulic hammer compaction as a surface wave generating point source. The corresponding geometric damping coefficients are summarized in Table 2.
4. The measured attenuation data matched well with the predicted data when using the suggested geometric damping coefficient, and the estimated damping ratios were quite reasonable taking soil type of the site and experiencing strain level into consideration.

Acknowledgements

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ENVIRONMENTAL ASSESSMENT

13610 Banks Crescent, Summerland

LOTS A, B, C PLAN 2091 AND LOT 1, PLAN 20906
PID # 011-218-860, 011-218-908, 011-218-932 & 007-679-076

DISTRICT OF SUMMERLAND

Prepared For:

MALEK TAWASHY
LARK GROUP
Suite #1500-13737 96th Avenue
Surrey, BC V3V 0C6

Prepared By:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.
#102 – 450 Neave Court
Kelowna, BC V1V 2M2

ECOSCAPE
Environmental Consultants Ltd.

May 2017

Ecoscape File No: 16-1837

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APPENDIX

1.0 INTRODUCTION

Ecoscape Environmental Consultants Ltd. (Ecoscape) has been retained by Lark Group (proponent) to provide environmental consulting services related to the proposed development of a seniors' residential care and multi-family development at 13610 Banks Crescent, Summerland, BC (subject property). The subject property is legally described as Lots A, B, and C, Plan 2091 (except Plans B4126 and KAP53034); and Lot 1, Plan 20906, District Lot 455 (Figure 1).

The proponent intends to re-zone the subject property from Agricultural (A1) to Comprehensive Development (CD8) to accommodate residential housing and urban services as well as amend the Official Community Plan to change the future land use designation from Agriculture to High Density Residential (HDR). The subject property occurs within a District of Summerland Environmentally Sensitive Development Permit Area (ESDPA); therefore, an environmental assessment is required to address the potential for adverse environmental effects resulting from the proposed development.

1.1 Background

Ecoscape provided an overview letter of environmental values in July 2016 in response to the immediate requirements outlined in the June 17, 2016 District of Summerland letter regarding the proponent's application to amend the OCP and Zoning Bylaw. The current report will provide a detailed Environmental Assessment for the subject property.

The purpose of this report is to address the conditions of the Environmentally Sensitive DPA guidelines as described in the District of Summerland Official Community Plan (OCP) (Bylaw No. 2014 – 002), to meet the requirements of the District of Summerland's Terms of Reference for Environmental Assessment Reports, as well as to expand on Ecoscape's previously submitted letter from July 18, 2016, which outlined environmental values within the subject property. This report provides a full environmental assessment of potentially existing terrestrial resource values, the potential for rare/endangered species and habitats, potential impacts of the proposed development, and subsequently provides mitigation measures to incorporate into development planning to protect and enhance the natural integrity of existing ecological communities.

The scope of this assessment does not include a hydrogeological / groundwater assessment or review of the potential impacts on groundwater in the surrounding area.

1.2 Study Area

The subject property is approximately 6.1 ha in size and the total proposed development footprint is 2.5 ha (Figure 1).

Existing site conditions include an operational vineyard and rural residential dwelling in the center of the subject property, surrounded by moderate to steep slopes. These warm-aspect slopes are characterized by sagebrush steppe, while the cool-aspect slopes are characterized by open woodland. Moisture-receiving gullies exist along the southwest portion of the property and are characterized by shrubs such as tall Oregon grape and Saskatoon. Silt bluffs are present along the northern boundaries of the subject property, where there is evidence of bird foraging and nesting. The surrounding land use is mixed urban residential with agricultural and rural areas. To the north exists a 0.4 ha lot designated as park land, while the west side of the property is bordered by Solly Road and Bristow Road. The south and east sides of the property are bordered by low density residential lots.

1.3 Proposed Works

The proposed works include the rezoning of the subject property from A1 to CD8, followed by the development and construction of a seniors' residential care and multi-unit development. The development footprint will be 22,881 m^2 and will include the multi-unit development including driveways, site servicing, a walking trail etc.

2.0 ENVIRONMENTAL ASSESSMENT

The most recent site visit was conducted on March 16, 2017 by Kyle Hawes, B.Sc., R.P.Bio., and Tina Deenik, B.Sc., Natural Resource Biologists with Ecoscape. During this site visit, additional details were collected and the previously described Terrestrial Ecosystem Mapping (TEM) polygons from the Sensitive Ecosystem Inventory (SEI) for South Okanagan (Iverson and Haney, 2012) were refined. The following section describes the natural conditions and values inherent within the study area, based on information collected during both site visits.

Other sources of information queried for the assessment include:

- District of Summerland Official Community Plan (Schedule "A" to Bylaw No. 2014-002);
- BC Conservation Data Centre (CDC) Species and Ecosystems Explorer and Species at Risk Mapping;
- District of Summerland GIS;
- Sensitive Ecosystem Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM); and
- Provincial Best Management Practices (BMP).

2.1 Ecosystem Communities and Vegetation

The subject property occurs within a transitional zone between the Okanagan Very Dry Hot Bunchgrass variant (BGxh1) biogeoclimatic zone and the Okanagan Very Dry Hot ponderosa pine (PPxh1) zone, described by the Biogeoclimatic Ecosystem Classification (BEC) program (Lloyd et al. 1990). The bunchgrass (BG) zone occurs at low elevations within the southern Okanagan and is the hottest and driest zone in British Columbia. The ponderosa pine (PP) zone is generally the driest forest region in BC, with hot dry conditions in the summer, and cool with little snow in the winter.

The existing Terrestrial Ecosystem Mapping (TEM) polygon extents were adjusted to address seral conditions and previous disturbance that has impacted of sites. Nine separate polygons represented by seven different classifications were identified within the subject property and are displayed in Table 1 and Figure 2.

Table 1. Ecosystem communities occurring within the subject property.

Ecosystem Code	PPxh1 & BGhx1 Site Series	Site Series Name	Provincial Status[1]
CV	-	Cultivated Vineyard	-
ES	-	Exposed Soils	-
OS	-	Oregon Grape-Saskatoon	-
PW*	01	Ponderosa Pine / Bluebunch Wheatgrass	Blue
PS	05	Ponderosa Pine / Sumac	Red
RW	-	Rural	-
SW	01	Big Sagebrush / Bluebunch Wheatgrass	Red

1 Source: http://www.env.gov.bc.ca/cdc/
Blue: Of special concern. **Red:** Endangered or threatened.
*Part of PPxh1 site series

Shrub Steppe Ecosystem

The subject property has south and southeast facing slopes along the north and west property boundaries as well as on Lot 1, Plan 20906, which are characterized by a shrub-steppe ecosystem dominated by big sagebrush (*Artemisia tridentate*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) (Polygons 2, 4, 6 & 8; Photo 1.). The big sagebrush / bluebunch wheatgrass (SW) ecosystem is a Red-listed community meaning it is considered endangered or at risk of becoming extirpated within the region.

Beginning in the northeast corner of the property, the slope toe bordering the vineyard is dominated by non-native black locust (*Robinia pseudoacacia*) and Siberian elm trees (*Ulmus pumila*) (Polygon 3, Photo 2.). Crested wheatgrass (*Agropyron cristatum*) dominates the ground cover in the shadow of these trees with native grasses and forbs being uncommon. Bluebunch wheatgrass becomes more prevalent further upslope with exposed soil and prickly pear (*Opuntia fragilis*). Persistent site disturbance and

frequent ungulate movement through this fragmented ecosystem has destroyed much of the cryptogamic crust with only small patches remaining (Photo 3).

Continuing to the west along the slope from the east property line, a section of weedy forbes and grasses, such as Russian thistle (*Salsola kali*), disrupts the shrub steppe ecosystem and occurs in association with a yard waste dumping site upslope of the subject property (Photo 4). To the west of this disturbance, the shrub steppe ecosystem continues with small silt bluffs (ES) at the top of the slope and mature elm trees at the toe (Polygon 2, Photo 5). Grasses here are mostly non-native crested wheatgrass as well as tufted white prairie aster (*Aster ericoides ssp. pansus*), with bluebunch wheatgrass occurring in the areas that are not shaded by the elm trees.

In the northwest corner of the subject property above the vineyard, there is a modified shrub steppe community with big sage, bluebunch wheatgrass and silver poplar (*Populus albus*) (Polygon 4, Photo 6). The aspect begins to shift east as you head south and Siberian elm trees are interspersed with common snowberry (*Symphoricarpos albus*), white clematis (*Clematis ligusticifolia*), and weeds such as Dalmatian toadflax (*Linaria dalmatica*). An old apple tree (*Malus* sp.) is also present in this corner of the property.

Woodland Ecosystems

Polygon 5 begins at northwest gully on the subject property and continues to the south adjacent to the vineyard. This polygon represents the cooler north and northeast aspects of the subject property and is characterized by an open canopy of ponderosa pine (PS) with a moderately well-developed shrub stratum with tall Oregon grape (*Mahonia aquifolium*) / Saskatoon (*Amelanchier alnifolia*) and common snowberry (OS) present in on lower slopes and moisture-receiving gullies (Photo 7). OS is not listed but PS is a Red-listed community.

Polygon 6 represents the warmer aspects associated with the large drainage gullies in the southwest portion of the subject property. Here, scattered ponderosa pine communities can be found on the upper slopes (PW) with sagebrush communities (SW) dominating the mid and lower slopes. The shrub community typical of OS is found in the gully bottoms here as well. The ponderosa pine / bluebunch wheatgrass (PW) ecosystem is a Blue-listed community meaning it is of special concern

The disturbed slopes of Polygons 5 and 6, have an abundance of invasive and non-native species such as Dalmatian toadflax, common mullein (*Verbascum thapsus*) diffuse knapweed (*Centaurea diffusa*), agronomic grasses and forbes, cleavers (*Galium aparine*), and hounds tongue (*Cynoglossum officinale*) (Photo 8). Native species such as Ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*) regeneration, Rocky Mountain juniper (*Juniperus scopulorum*), tall Oregon- grape, big sagebrush, and common snowberry are also growing here with Saskatoon and Douglas maple (*Acer*

glabrum) in the gullies. Feathermosses were present on steep, cool aspect slopes (Photo 9).

Anthropogenic Communities

The rural and cultivated vineyard communities (CV and RW) are largely represented by Polygons 1, 3, 7, and 9 and are not considered sensitive to development (Photo 10). Polygon 4 has a small amount of rural disturbance on the upper slopes as well.

2.2 Aquatic Resources

No aquatic resources were documented within the subject property. However, a broad moisture-receiving area occurs 50-m downslope to the southeast and is the location of emerging ground water known as Shaughnessy Springs. This spring supplies the Freshwater Fisheries Society Summerland Trout Hatchery. A detailed Hydrogeological Assessment including a review of groundwater systems, was completed by Piteau Associates, dated July 2016, and can be found on the District of Summerland's webpage. Two fish-bearing creeks are located within 500 m of the subject property. Eneas Creek is located 450 m north of the property and Prairie Creek is located 250 m south of the property. Development is not anticipated to impact either of these watercourses.

2.3 Wildlife

This section provides incidental wildlife observations made onsite during the July 2016 and March 2017 site visits.

The vineyard and rural residential area generally have a low suitability for wildlife. Similarly, the Siberian elm and black locust treeline that is established along the northern fringe of the vineyard over the lower shrub steppe slopes is degrading the value of this fragmented ecosystem for wildlife.

Birds

Several mature ponderosa pine trees we documented on the western boundary of the subject property, upslope of the vineyard. These trees and associated grassland and shrub-steppe ecosystems may provide moderate value nesting habitat for woodpeckers and other avian species in the area. No raptor nests, cavities, or woodpecker activity was observed during the site visit; however, the silt bluffs present along the northern boundaries of the subject property showed evidence of bird foraging for insects and possible nesting (Photo 11. Bird foraging activity within silt bluffs (photo taken July, 2016).). Development will not impact the silt bluffs as they are beyond the development footprint.

Species recorded onsite during the July 2016 site visit included: American Crow (*Corvus brachyrhynchos*), American Robyn (*Turdus migratorius*), Black-billed Magpie (*Pica hudsonia*), California Quail (*Callipepla californica*), Clarke's Nutcracker (*Nucifraga columbiana*), European Starling (*Sturnus vulgaris*), House Finch (*Haemorhous mexicanus*), Northern Flicker (*Colaptes auratus*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), Oriole species (*Icterus* spp.), and Red-eyed Vireo (*Vireo olivaceus*).

Species recorded onsite during the March 2017 environmental assessment included: American Crow (*Corvus brachyrhynchos*), American Robyn (*Turdus migratorius*), Black-billed Magpie (*Pica hudsonia*), California Quail (*Callipepla californica*), Cedar Waxwing (*Bombycilla cedrorum*), Dark-eyed Junco (*Junco hyemalis*), Eurasian Collared Dove (*Streptopelia decaocto*), European Starling (*Sturnus vulgaris*), House Finch (*Haemorhous mexicanus*), House Sparrow (*Passer domesticus*), Northern Flicker (*Colaptes auratus*), Pygmy Nuthatch (*Sitta pygmaea*), Song Sparrow (*Melospiza melodia*), and Tree Swallow (*Tachycineta bicolor*).

Mammals

There was evidence of recent deer utilization (tracks and scat) observed onsite throughout the shrub steppe and vineyard. There are abundant browse opportunities that exist in the shrub-dominated communities within the subject property. Inactive burrows occurred throughout the subject property (Photo 12), and are likely to be due to Yellow-bellied Marmot (*Marmota flaviventris*) activity as one was observed during the March site visit.

Reptiles

The subject property generally has moderate habitat suitability for reptile species of concern (e.g., Racer, Western Rattlesnake, Gopher Snake and Rubber Boa) due to the warm south aspects of the site and the hunting opportunities of rodents such as mice, voles and gophers in the vineyard and the friable soils provided by the adjacent hillslopes. Although this site may provide hunting opportunities and possible nesting on south-facing slopes, it is lacking important, security and thermal habitats (e.g. talus slopes and fragmented rock outcrops) for hibernation / denning and general cover. Development activity will not impact the south-facing shrub-steppe ecosystem where potential snake habitat may occur.

2.4 Species at Risk

Species at risk are identified in the context of provincial and national ranking systems. The provincial ranking system applies to species that have been assessed by the BC Conservation Data Centre (CDC). The national ranking system applies to species that

have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Due to the timing and duration of the site visit, it was not possible to identify the presence of rare or endangered wildlife that may occasionally use the site. We have provided a habitat review rather than a complete rare plant or animal survey, the results of which can be found in Tables 2 and 3. In addition, species and ecosystems at risk as well as wildlife species inventories were queried within a 2 km radius of the subject property using the Ministry of Environment's iMapBC, the results of which are provided below. The Open Government Portal Maps of BC Biota was also queried for critical habitat for species at risk.

The following results include only those species that have the potential to occur within the subject property and have been noted within a 2 km radius. The subject property occurs within a masked CDC area as well as within the range of the red-listed American Badger (*Taxidea taxus*), which extends from the U.S. border to the north end of Okanagan Lake (Shape ID 74373, Occurrence ID 10214). Shape ID 104496, Occurrence ID 13237 is located 1.1 km southwest of the subject property and represents the sighting of the Blue-listed North American Racer (*Coluber constrictor*) in 2014. Shape ID 79069, Occurrence ID 10630, is located 1.3 km from the subject property and represents the sighting of a Blue-listed Gopher Snake (*Pituophis catenifer deserticola*) in 2011. Shape ID 6554, Occurrence ID 1504, represents the sighting of the Blue-listed Vivid Dancer (*Argia vivida*) in 2011, 700 m north of the subject property. The online Wildlife Species Inventory iMap revealed the following species within a 2 km radius of the subject property: White-throated Swift (*Aeronautes saxatalis*), Western Screech Owl (*Megascops kennicottii*), Lewis's Woodpecker (*Melanerpes lewis*), and Vivid Dancer (*Argia vivida*). The BC Open Maps for Biota revealed that critical habitat for Lewis's Woodpecker (*Melanerpes lewis*) occurred within 0.8 km of the subject property.

It should be noted again that the development area, within the cultivated vineyard, has low habitat suitability for wildlife, particularly provincially ranked and/or federally listed species.

Table 2: Summary of wildlife species at risk with the potential to occur within the study area.

Class	Scientific Name	Common Name	COSEWIC	BC List
Amphibians	*Anaxyrus boreas*	Western Toad	SC (Nov 2012)	Blue
	Spea intermontana	Great Basin Spadefoot	T (Apr 2007)	Blue
Birds	*Ammodramus savannarum*	Grasshopper Sparrow		Red
	Buteo swainsoni	Swainson's Hawk		Red
	Chondestes grammacus	Lark Sparrow		Blue
	Chordeiles minor	Common Nighthawk	T (Apr 2007)	Yellow
	Coccothraustes vespertinus	Evening Grosbeak	SC (Nov 2016)	Yellow
	Empidonax wrightii	Gray Flycatcher	NAR (May 1992)	Blue
	Hirundo rustica	Barn Swallow	T (May 2011)	Blue
	Megascops kennicottii macfarlanei	Western Screech-Owl, *macfarlanei* subspecies	T (May 2012)	Red
	Melanerpes lewis	Lewis's Woodpecker	T (Apr 2010)	Blue
	Sphyrapicus thyroideus	Williamson's Sapsucker, *thyroideus* subspecies	E (May 2005)	No Status
	Spizella breweri	Brewer's Sparrow, *breweri* subspecies		Red
	Tyto alba	Barn Owl	T (Nov 2010)	Red
Insects	*Apodemia mormo*	Mormon Metalmark	E (May 2014)	Red
	Callophrys affinis	Immaculate Green Hairstreak		Blue
	Cicindela decemnotata	Badlands Tiger Beetle		Red
	Cicindela pugetana	Sagebrush Tiger Beetle		Blue
	Danaus plexippus	Monarch	E (Nov 2016)	Blue
	Hesperia nevada	Nevada Skipper		Blue
	Lycaena nivalis	Lilac-bordered Copper		Blue
	Satyrium californica	California Hairstreak		Blue
Mammals	*Corynorhinus townsendii*	Townsend's Big-eared Bat		Blue
	Euderma maculatum	Spotted Bat	SC (Nov 2014)	Blue
	Myotis thysanodes	Fringed Myotis	DD (May 2004)	Blue
	Perognathus parvus	Columbia Plateau Pocket Mouse		Blue
	Reithrodontomys megalotis	Western Harvest Mouse	SC (Apr 2007)	Blue
	Sorex merriami	Merriam's Shrew		Red
	Sorex preblei	Preble's Shrew		Red
	Taxidea taxus	American Badger	E (Nov 2012)	Red
Reptiles	*Charina bottae*	Northern Rubber Boa	SC (Apr 2016)	Yellow
	Coluber constrictor	North American Racer	T (Nov 2015)	Blue
	Crotalus oreganus	Western Rattlesnake	T (May 2015)	Blue
	Pituophis catenifer deserticola	Gopher Snake, *deserticola* subspecies	T (Apr 2013)	Blue
	Plestiodon skiltonianus	Western Skink	SC (Nov 2014)	Blue

Source: http://www.env.gov.bc.ca/cdc/
Search criteria: Animals AND MOE Regions: 8- Okanagan (Restricted to Red, Blue, and Legally designated species) AND Regional Districts: Okanagan-Similkameen (OSRD) (Restricted to Red, Blue, and Legally designated species) AND Habitat Subtypes: Conifer Forest - Dry (Restricted to Red, Blue, and Legally designated species) AND BGC Zone: BG, PP
Yellow: Not considered at risk. Blue: Of special concern. Red: Endangered or threatened.

EXTIRPATED (XT): A species that no longer exists in the wild in Canada, but occurring elsewhere. ENDANGERED (E): A species facing imminent extirpation or extinction. THREATENED (T): A species that is likely to become endangered if limiting factors are not reversed. SPECIAL CONCERN (SC): A species of special concern because of characteristics that make it is particularly sensitive to human activities or natural events. NOT AT RISK (NAR): A species that has been evaluated and found to be not at risk. DATA DEFICIENT (DD): A species for which there is insufficient scientific information to support status designation.
Note: Only individuals with the possibility of occurring at the subject property based on existing conditions are displayed here.

Table 3: Summary of plant species at risk with the potential to occur within the study area.

Family	Scientific Name	Common Name	COSEWIC	BC List
Fabaceae	*Astragalus spaldingii*	Spalding's milk-vetch		Red
Brassicaceae	*Boechera sparsiflora*	stretching suncress		Red
Asteraceae	*Brickellia oblongifolia* var. *oblongifolia*	narrow-leaved brickellia		Blue
Asteraceae	*Erigeron poliospermus* var. *poliospermus*	cushion daisy		Blue
Onagraceae	*Gaura coccinea*	scarlet gaura		Red
Polemoniaceae	*Gilia sinuata*	shy gilia		Red
Polemoniaceae	*Lathrocasis tenerrima*	slender gilia		Red
Polemoniaceae	*Leptosiphon harknessii*	Harkness' linanthus		Red
Fabaceae	*Lupinus sulphureus*	sulphur lupine		Red
Onagraceae	*Neoholmgrenia andina*	Andean evening-primrose		Red
Solanaceae	*Nicotiana attenuata*	wild tobacco		Red
Orobanchaceae	*Orobanche corymbosa* ssp. *mutabilis*	flat-topped broomrape		Blue
Scrophulariaceae	*Orthocarpus barbatus*	Grand Coulee owl-clover	E (May 2005)	Red
Boraginaceae	*Pectocarya penicillata*	winged combseed		Red
Polemoniaceae	*Phlox speciosa* ssp. *occidentalis*	showy phlox	T (Nov 2004)	Red
Brassicaceae	*Sandbergia whitedii*	Whited's halimolobos		Blue
Malvaceae	*Sphaeralcea coccinea*	scarlet globe-mallow		Red
Malvaceae	*Sphaeralcea munroana*	Munroe's globe-mallow		Red
Poaceae	*Achnatherum thurberianum*	Thurber's needlegrass		Red
Poaceae	*Hesperostipa spartea*	porcupinegrass		Blue
Poaceae	*Melica bulbosa*	oniongrass		Blue
Poaceae	*Poa fendleriana* ssp. *fendleriana*	mutton grass		Red

Source: http://www.env.gov.bc.ca/cdc/
Search criteria: Plants AND MOE Regions: 8- Okanagan (Restricted to Red, Blue, and Legally designated species) AND Regional Districts: Okanagan-Similkameen (OSRD) (Restricted to Red, Blue, and Legally designated species) AND Habitat Subtypes: Conifer Forest - Dry (Restricted to Red, Blue, and Legally designated species)
AND BGC Zone: BG, PP
Yellow: Not considered at risk. Blue: Of special concern. Red: Endangered or threatened.
ENDANGERED (E): A species facing imminent extirpation or extinction. THREATENED (T): A species that is likely to become endangered if limiting factors are not reversed.
Note: Only individuals with the possibility of occurring at the subject property based on existing conditions are displayed here.

2.5 Environmentally Sensitive Areas

To determine the ESA rating, criteria such as stand, landscape, regional rarity, successional stage, structural complexity, and levels of disturbance were all considered in the determination of environmental sensitivity. Further, wildlife habitats as they relate to species at risk, connectivity, adjacency, and edge effects were also considered. Based upon these criteria, professional judgment was used to determine the sensitivity of the subject property. Ecosystem condition (i.e. level of disturbance, invasive species presence, etc.) is also considered when evaluating ecosystem units. The assessment also addresses the potential for conservation and wildlife movement corridors, and measures to reduce the effects of fragmentation and isolation from adjacent natural habitats.

The following describes the four-class ESA rating system provided by the District of Summerland that was used for the assessment:

a) ESA – 1 High: Locally and provincially significant ecosystems, extremely rare and/or of critical importance to rare wildlife species. These areas may also represent a diverse range of habitats and contribute significantly to the overall connectivity of the habitat and ecosystems. Avoidance and conservation of ESA-1 designations is the primary objective.

b) ESA – 2 Moderate: Locally or provincially significant ecosystems, uncommon and important to rare wildlife species. ESA-2 should be avoided, but if development is pursued, portions of the habitat must be retained and integrated to maintain the contiguous nature of the landscape. Some loss to these ESAs can be offset by habitat improvements to the remaining natural areas found on the property.

c) ESA – 3 Low: Ecosystems that may have low to moderate conservation values because of importance to wildlife (e.g. disturbed or fragmented ecosystems or habitat features). These areas may contribute to the diversity to the landscape, although based on the condition and adjacency of each habitat the significant function within the landscape is limited. If development is pursued in these areas the impacts should be offset by habitat improvements in other more sensitive natural areas found on property.

d) ESA – 4 Not Sensitive: Little or no inherent ecological value or importance as wildlife habitat. The majority of development should occur within ESA-4 areas.

The subject property consists of 48.1 % Low-value ecosystems (ESA 3), 29.5 % Moderate-value ecosystems (ESA 2), and 22.4 % High-value ecosystems (ESA 1) (Table 4, Figure 3). The cultivated vineyard within the subject property is rated as ESA 3 because it is highly disturbed, and lacks suitable habitat and environmentally valuable resources for species at risk. The surrounding shrub steppe and shrub dominated woodland ecosystems are rated as ESA 2 due to natural habitat value containing red-

listed communities (PS and SW) but with disturbances and the presence of invasive species. It also lacks connectivity to other valued ecosystems. The ESA 1 areas are rated High due to the presence of natural, largely undisturbed open woodland and shrub steppe ecosystems with silt bluffs and the presence of a red-listed community (SW) and blue-listed community (PW).

The entire development disturbance footprint is approximately 22,881 m², or 36.5 % of the subject property, while 63.5 % will remain undisturbed. The development footprint is primarily located within the already-disturbed vineyard area in the center of the subject property (Polygon 1). This area has a Low-value ESA rating (3) due to the disturbed cultivated field, lack of high-value habitat, and lack of connectivity. The western boundary of the subject property also has a Low-value ESA rating (3) due to edge effect and adjacency to a road way and rural developed area. The sloped area surrounding the vineyard has a Moderate-value ESA (2) due to the natural shrub steppe ecosystem, however it is on the lower end of the scale due to the presence of invasive and non-native plants and is not equivalent to other ESA 2 areas that are less disturbed, and have greater connectivity and continuity with adjacent areas. There will be slight encroachment into the High-value ESA by and area of approximately 16.8 m² which represents approximately 0.1 % of the High-value ESA within the subject property. This impacted ESA 1 is directly adjacent to an ESA 3, and is likely closer to an ESA 2, than a true ESA 1 (Figure 3). Approximately 2,031.7 m² of Moderate-value ESA will be disturbed which represents 10.9 % of the Moderate-value ESA within the subject property. Overall the majority of the development (69.1%) is located within Low-value ESA within the subject property.

In order to offset the 2,031.7 m² development of the Moderate-value ESA, habitat improvements and restoration are proposed in other natural areas throughout the subject property (refer Section 4.6 below).

The following values in Table 4 apply to the subject property (Figure 3):

Table 4. Percent composition of ESA lost to development within the study area.

ESA Value	ESA Area Within Development Footprint (m²)	ESA Area Outside Development Footprint (m²)	Total ESA Area Within Subject Property (m²)	ESA Lost to Development (%)	ESA Retained (%)
High (ESA 1)	16.7	14,020.3	14,037	0.1	99.9
Moderate (ESA 2)	2,031.7	16,473.3	18,505	10.9	89
Low (ESA 3)	20,832	9,303	30,135	69.1	30.9
Nil (ESA 4)	0	0	0	0	0
Total	22,881.2	39,796.6	62,677.8	-	-

2.5.1 Re-Design Summary

The following summarizes design changes that have been made to minimize disturbance within High and Moderate-value ESAs throughout the development permitting process:

- Electrical servicing was to occur underground, and was encroaching into ESA 1. To reduce the footprint of impact, an overhead power service has been included, reducing ground disturbance within both ESA 1 and ESA 2.
- The retaining wall footprint has been reduced, which limits encroachments into ESA 1. This reduction has almost entirely avoided ESA 1.
- The retaining wall reduction also occurred with a reduction in the building footprint to avoid ESA 1 as well.

3.0 IMPACT ASSESSMENT

3.1 Potential Impacts

Potential environmental impacts from proposed development are typically associated with the clearing, grubbing, and earthworks required for construction of permanent structures, including site servicing, driveways, and other infrastructure. The following section provides an overview of potential impacts to terrestrial resources on the property from development. Provincial best management practices (BMPs) and mitigation measures must be incorporated into the planning and construction phases. Many impacts can be mitigated through the implementation of BMPs and mitigation measures. If mitigation measures are not adhered to, there is the potential for environmental impacts to occur as described below.

- Potential for the release of deleterious substances (e.g., fuel, oil, hydraulic fluid) to the environment as a result of improper storage, equipment re-fueling, and/or poorly maintained equipment.
- Potential for the release of fine sediment down slope to adjacent aquatic values, such as Shaughnessy Spring. This can be mitigated by following best management practices for preventing surface runoff.
- Encroachment into steep slopes could potentially occur if disturbance limits or covenant boundaries are not properly identified and clearly marked in the field prior to initiation of site clearing and grading.

- Potential to directly or indirectly impact wildlife and their habitat, such as herptiles, avian species, and small mammals within the vineyard, silt bluffs, and adjacent shrub communities, during clearing, earthworks, and roadworks. This includes disruption of migration, breeding, or other behavior, as a result of tree falling, site grading, construction noise, impacts to air quality, and other alterations to existing wildlife habitat and cover. The subject property generally has low habitat suitability for wildlife species of concern. Thus, it is not anticipated that the development will harm or displace wildlife species of concern.

- Establishment of invasive weeds would deteriorate wildlife habitat and natural condition of surrounding shrub steppe and woodland ecosystems.

As with any land development, there will be an incremental loss of natural lands, and this incremental loss has not been fully considered in a Cumulative Impacts Assessment as part of this report. This cumulative impacts assessment goes beyond what is typical of an impact assessment for sites of this size, as they are typically completed for larger, more regional-type assessments. In addition to the impacts listed above, there is the potential for activities associated with the senior's residential care and multifamily development to impact terrestrial areas through encroachment into Environmentally Sensitive Areas. As these impacts result from human activities, they are highly variable and thus hard to account for.

4.0 MITIGATION MEASURES AND RECOMMENDATIONS

4.1 General

Ecoscape provides the following general mitigation strategies for development within the study area, based on the existing ecosystems and environmental sensitivity analysis. In addition to the recommendations provided herein, the proponent and individual property owners can find additional information on best management practices in the following documents (the URL for these reference documents has been provided in parentheses so that they can be sourced online):

- All works must generally conform to the Develop with Care Environmental Guidelines for Urban and Rural Land Development in British Columbia (2014) (http://www.env.gov.bc.ca/wld/BMP/bmpintro.html#second)

- Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia (2014) (http://www.env.gov.bc.ca/wld/documents/bmp/HerptileBMP_complete.pdf)

- Best Management Practices for Amphibian and Reptile salvages in British Columbia (2016) http://a100.gov.bc.ca/pub/eirs/finishDownloadDocument.do;jsessionid=vQ4jXRsDC5mQXkGb1H3GYHGKyT712l7LGjmx818Ksg9hclhpXQ5B!101758496?subdocumentId=10351

- Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (2013) (http://www.env.gov.bc.ca/wld/documents/bmp/raptor_conservation_guidelines_2013.pdf)

Some of the recommendations included in this report were obtained from these reference documents. The pertinence of the provided recommendations will depend on the final construction plan and selected contractor. A complete Environmental Protection Plan (EPP) or Construction Environmental Management Plan (CEMP) should be prepared and submitted to support a Development Permit process. This plan will formalize the generic recommendations made below. The EPP or CEMP should include the following general mitigation strategies for site development.

4.2 Conservation and Connectivity

This property is surrounded by low-density rural development and is considered isolated from surrounding critical habitat values, therefore it is not considered a prime wildlife corridor. Any animals that are using this area as a corridor are not likely to be impeded so long as the Moderate- and High-value ESA areas surrounding the cultivated vineyard area and development footprint are left natural or restored as per the recommendations in Section 4.6 below.

4.3 Clearing and Grubbing

- Prior to any disturbance within the site, the limits of disturbance with site grading and lot establishment must be clearly marked in the field by a legal surveyor and delineated with brightly coloured snow fence to prevent unnecessary encroachment into adjacent steep slopes and natural areas. Permanent fencing may be necessary along some buffers where development and/or related-activity are anticipated.

- Native vegetation, including trees, shrubs, and groundcover, must be retained where possible during any future development planning and design to mitigate the establishment of invasive plants and to maintain the existing ecological value sustained within the study area. Standing dead trees (snags) and coarse woody debris should also be retained where possible for the critical wildlife habitat value they provide.

- Vegetation, soil and rock excavated from the development footprint must be taken offsite and disposed of/recycled appropriately, or stored onsite within disturbed areas of the development footprint if reuse onsite is proposed. No sidecasting of material over steep slopes or storage of material can occur outside of the development footprint.

- In the event that land and/or natural vegetation is disturbed or damaged beyond the development footprint area, these areas must be restored and/or replanted with plants indigenous to the area under the direction of the EM.

- Equipment and vehicle access must use existing roads, trails, and other disturbed areas to minimize the disturbance footprint.

- Limit cuts and fills and wherever possible, alter the development to suit the local topography.

- Maintain natural drainage patterns where feasible.

- If clearing activities are required during the identified avian nesting period (i.e., April 1 to August 30), pre-clearing surveys must be conducted by the EM to identify active nests and other critical habitat features, such as burrows, dens, etc. Surveys will focus on songbird, raptor and heron nests, stick nests, and snags and cavities that may be used over multiple years or year-round (i.e., winter resident and hibernating species). Section 34 of the *Wildlife Act* protects all birds and their eggs, and Section 34(c) protects their nests while they are occupied by a bird or egg.

- If active nests are found within the clearing limits, a buffer will be established around the nest until such time that the EM can determine that nest has become inactive. The size of the buffer will depend on the species and nature of the surrounding habitat. Buffer sizes will generally follow provincial BMP guidelines or other accepted protocol (e.g., Environment Canada). In general, a minimum 20 m buffer will be established around songbird nests or other non-sensitive (i.e., not at risk) species.

- Clearing and other construction activities must be conducted within 72 hours following the completion of the pre-clearing nest surveys. If works are not conducted in that time, the nest surveys are considered to have expired and a follow-up survey will be completed by the EM to ensure that no new nests have been constructed.

- Contractors, construction workers, and the public should be educated about the presence of herptile species that may occur within the subject property and shown how to limit disturbance and re-locate individuals if necessary. A link to BMPs for amphibian and reptile salvage are included above.

4.4 Erosion and Sediment Control

In this section, Ecoscape provides general mitigation measures to address sediment control during construction works due to surface run-off. Please note that a full Geotechnical Assessment, including a slope stability hazard assessment, was completed by Rock Glen Consulting Ltd., dated September 2016, and can be found on the District of Summerland's website.

- Silt fencing will be installed as directed by the EM in a field-fit manner, generally along the clearing and grading limits and/or in areas where sediment-laden flows may be conveyed offsite such as steep slopes. Silt fencing will be required along the southeast toe of the development footprint to protect aquatic resources downhill.

- Silt fence must be staked into the ground and trenched a minimum of 15 cm to prevent flow underneath the fence, as per the manufacturer's specifications. Silt fencing will be monitored on a regular basis and any damages or areas where the integrity and function of the fencing has been compromised must be repaired or replaced promptly.

- Silt fence must remain in place where required until the completion of the project. Other sediment and erosion control measures may include check dams (e.g., rock, sand bag, hay bales) to slow flows along drainage channels and ditch lines, sumps, or other settling areas for turbid waters.

- The release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substances into any drainage, gully, or storm water system must be prevented at all times.

- Develop roads, utilities, and building sites with as little soil excavation and disturbance as possible.

- Erosion and sediment control materials such as silt fence, straw wattles, sand bags, erosion control matting, etc. must be readily available during construction and used to address erosion problems as they arise.

- Seed and re-vegetate cuts and fills as well as disturbed slopes as early as possible following clearing activities.

- Consider incorporating more permeable surfaces into development areas where it is practical and safe to do so, as a design best practice. This will encourage water infiltration to ground instead of increasing overland flow and runoff.

- Exposed soils along slopes and temporary stockpiles must be stabilized and covered where appropriate using geotextile fabric, poly sheeting, tarps, or other

suitable materials to reduce the potential for erosion resulting from rainfall, seepage, or other unexpected causes.

- Adjacent roadways must be kept clean and free of fine materials. Sediment accumulation upon the road surfaces must be removed and disposed of appropriately. This may require the installation of a clean blast-rock pad at the ingress/egress point for the development to reduce the amount of sediment material conveyed offsite during hauling activities.

4.5 Emergency Spill/Response Plan

Spills of deleterious substances can be prevented through awareness of the potential for negative impacts and with responsible housekeeping practices onsite. Maintenance of a clean site and the proper use, storage and disposal of deleterious liquids and their containers are important to mitigate the potentially harmful effects of spills and/or leaks. The following BMP are adapted from Chilibeck et al. (1992) to provide guidance in the control of deleterious substances:

- Spills occurring on dry land will be contained, scraped and disposed of appropriately. Contaminated material will be stored on tarps and covered to prevent mobilization, and will be disposed of in accordance with the *Environmental Management Act.*

- Copies of contact phone numbers for notification of all the required authorities in the event of a spill/emergency response will be kept posted and clearly visible onsite.

- Spill containment kits must be kept readily available onsite during construction in case of the accidental release of a deleterious substance to the environment. Any spills of a reportable amount of a toxic substance must be immediately reported to Emergency Management BC's 24-hour hotline at 1-800-663-3456.

4.6 Site Cleanup and Restoration

Effective site cleanup and restoration refers to returning a site to a state resembling the original habitat characteristics. Grassland ecosystems, including shrub steppe, are being heavily impacted by urban development and agriculture. Many Red and Blue-listed species found in the South Okanagan are those that depend on grassland ecosystems for habitat (MOE, 1998). To offset development encroachment into the Moderate and High-value ESA, Ecoscape recommends restoration of the surrounding shrub steppe ecosystems:

- Remove non-native elm and locust trees located throughout the subject property, primarily to the north of the vineyard where they are shading the

natural shrub steppe ecosystem that exists on the toe of the north facing aspect above. The area consists of the strip of Polygon 3 that is located between Polygon 1 and 2. Removal of the non-native trees will likely require multi-year removal, in addition the area must be seeded as described below. Provided that the non-native trees are removed adequately and seeding occurs, it is anticipated that natural infill from the adjacent sagebrush community should occur.

- Remove non-native elm and silver poplar present above the northwest corner of vineyard where they are shading the natural shrub steppe ecosystem. Weed management is necessary for this area to restore the shrub steppe ecosystem. Specific strategies for invasive plant management are provided in section 4.6.1 below.

4.6.1 Invasive Plant Management

As part of the restoration of the site and prevention of ecological degradation, the principles of a noxious weed management plan are provided below. The intent of the weed management plan will be to restore the area's natural integrity and to reduce the potential to spread noxious weeds within or beyond the construction site. The basic principles include: Removal of existing weed species, suppression of weed growth, prevention or suppression of weed seed production, reduction of weed seed reserves in the soil, and prevention or reduction of weed spread.

Dominant Invasive Plant Species

As a part of the recommended restoration for offsetting the development footprint, invasive plant species within the remaining subject property must be removed. The dominant invasive plant species found within these areas, as well as effective control measures, are provided in Table 5.

Table 5. Invasive species present on site.

Botanical Name	Common Name	Description	Mechanical Control	Biological Control
Cynoglossum officinale	Hound's tongue	Taproot biennial or short-lived perennial. Grows up to 1.2 m tall. Contains toxic alkaloids which cause liver damage if consumed. Produces up to 4000 seeds per year and buried seeds do not typically survive longer than one year. Spreads readily on animals with its burred seeds.	Reduce seed production by hand-pulling, mowing or cutting smaller infestations of second-year plants after they have bolted, prior to seeding Repetition is likely necessary First year rosettes should be hand-pulled or dug out, as nutrient reserves in the taproot will sustain the	Coordinate with the Ministry of Forests, Lands and Natural Resources (MFLNRO) for large infestations: Hound's tongue root weevil (*Mogulones cruciger),* Flea beetle (*Longitarsus quadriguttatus*)

Botanical Name	Common Name	Description	Mechanical Control	Biological Control
		Flowering occurs from May through July	plant if it has been cut Efforts should be made to remove as much of the taproot as possible	
Centaurea diffusa	Diffuse knapweed	Taproot biennial or short-lived perennial. Heavy seeds that are readily dispersed by wind, seed drop, humans, animals and vehicles. Produces up to 18 000 seeds per year. Flowering occurs in July, with seed set in August	Small infestations should be a priority and can be treated by hand pulling - this will need to be repeated Cutting or mowing in June or July (early in the flowering stage) can reduce seed production, but should occur prior to seed set to prevent further spread Repetition of treatment will be required as seeds are viable in the soil for several years Disturbed areas should be seeded with Certified grade 1 seed mix immediately following disturbance or treatment method to provide competition and limit reestablishment	Coordinate with the MFLNRO for large infestations: Beetle *(Sphenoptera jugoslavica)*, Fly *(Chaetorellia acrolophi)*, Fly *(Urophora affinis)*, Fly *(Urophora quadrifasciata)*, Fungus *(Sclerotinia sclerotiorum)*, Moth *(Agapeta zoegana)*, Moth *(Pelochrista medullana)*, Moth *(Pterolonche inspersa)*, Nematode *(Subanguina picridis)* (gall forming), Weevil *(Cyphocleonus achates)*, Weevil *(Larinus minutus)*, Weevil *(Larinus obtusus)*, Stem and leaf rust *(Puccinia jaceae)*
Linaria genistifolia ssp. dalmatica	Dalmatian toadflax	Provincially noxious perennial which forms a deep root system, with a taproot which can extend up to 1.2 m into the ground and horizontal roots that can spread up to 3.7 m. Seeds are small and a single plant can produce as many as 500 000 seeds per year. Dalmatian toadflax flowers from May to August and seed set occurs from July to September. Seeds can remain viable in the soil up to 10 years and treatment options will need to be repeated to be effective at reducing the seed bank over established areas.	Management of Dalmatian toadflax is most optimal in June when carbohydrate reserves are low. It is beneficial to repeat treatments in late June and early July to catch additional plants. Treatment should take place prior to seed set to minimize further spread. Overseed disturbed areas with a competitive Certified Grade 1 seed mix to provide competition. Physical means of control include hand pulling small infestations. Cutting to ground level in early summer, in the early stage of flowering, can limit seed	Coordinate with the MFLNRO for large infestations: *Brachypterolus pulicarius* – Beetle, *Calophasia lunula* – Moth, *Eteobalea intermediella* – Moth, *Eteobalea serratella* – Moth, *Mecinus janthinus* – Beetle (weevil), *Rhinusa antirrhini* – Beetle (weevil), *Rhinusa linariae* - Beetle (weevil), *Rhinusa neta* – weevil

Botanical Name	Common Name	Description	Mechanical Control	Biological Control
			production. Hand pulling and cutting will need to be repeated in an area several years to reduce the viable seed bank.	
Verbascum thapsus	Great mullein	Taprooted biennial that grows up to 2 m tall and occurs sporadically within the study area. It is not identified as a provincially or regionally noxious species and is not a priority species at the Rose's Pond site. If desired, removal of these plants can be done by hand pulling or cutting as they are identified within the study area.	If seeds are present, plants should be cut and bagged and disposed of in the garbage - never composted.	

- Prevention of the spread of non-native and invasive species can be achieved by limiting disturbance to soils and native vegetation where possible. Areas that have previously been disturbed or disturbed through the proposed development must be restored with grass seeding under the direction of the EM. Infestation areas must be controlled with regular manual removal of weeds (e.g., mowing, pulling), which should only occur before they have flowered or gone to seed. The use of herbicide treatments is not recommended.

- Invasive plant species must be disposed of in the landfill; however, invasive species material must not be composted in the yard waste section of the landfill. Invasive plant species must not be transported to or deposited in other natural areas.

- Upon completion of construction all exposed soils including the roadway cuts, fill areas and any areas where invasive plant removal has occurred must be

hydroseeded. At a minimum, hydroseed or loose grass seed must be applied to re-vegetate areas that have been disturbed, this must be completed under the direction of the EM. The anticipated areas include the following;

- proposed utility line installation areas;
- disturbed areas resulting from the walkway construction;
- Cut/fill slopes adjacent to the driveway access;
- Bulk excavation area; and,
- Areas disturbed through non-native tree removal (Polygon 3).

- Slopes steeper than 2:1 should be stabilized with erosion matting or equivalent material following grass seeding. Other appropriate measures include erosion control blankets, geo-textile fabrics, or mulch to cover and stabilize exposed soils.

- Grass seed must be Canada Agricultural Grade #1 to minimize weed seed counts and a native mix of hydroseed grasses. A suitable grass seed mix is provided below. Alternative mixes must be reviewed and approved by the EM prior to application. The grass seed mixture must not contain native varieties and/or non-native varieties that are known to be noxious or invasive. Fodder species such as clover and alfalfa must not be included in the mixture.

Table 6. Recommended upland grass seed mix

Seed Weight	Botanical Name	Common Name
40%	*Pseudoroegneria spicata*	bluebunch wheatgrass
25%	*Festuca campestris*	rough fescue
15%	*Festuca idahoensis*	Idaho fescue
10%	*Lolium perenne*	perennial ryegrass
5%	*Poa secunda*	Sandberg bluegrass
4%	*Koeleria macrantha*	junegrass
1%	*Poa compressa*	Canada bluegrass

- Timing of grass seeding is critical to optimize success and it is recommended that seeding should occur in late spring between April and June or late summer/early fall in September. Overseeding (to obtain adequate coverage and reduce competition by invasive plant species) is required at least twice during the growing season. Timing should occur once between April and June and once in September. Seeding over multiple years may be required to gain adequate coverage.

- Grass seed should be at sufficient density that no more than 50% of surface soil is visible when rough cut areas are mown to a height of 100 mm.

- If fertilizer is used, the forest fertilization guidebook recommends a urea-ammonium sulphate fertilizer blended to deliver 175–200 kg N/ha and 50–60 kg S/ha.

- Silt fencing and other temporary mitigation features must be removed upon substantial completion of works if the risk of surface erosion and sediment transport has been adequately mitigated with other permanent measures. This will be under the guidance of the EM.

4.6.2 Slope Restoration

Given the nature of slopes on the subject property, methods that enhance erosion control are recommended (i.e., hydroseeding with a tackifier, creation of planting pockets, and overplanting). The following measures are proposed for the restoration of slopes that will be disturbed during the proposed development (mainly through utility servicing and a walking trail) within the subject property:

- Manual/mechanical removal of invasive plant species throughout the slope. Herbicides/pesticides must be avoided given potential to impact native vegetation. Invasive species removal will require ongoing maintenance. Refer to Section 4.6.1 above for specific details.

4.7 Air Quality and Greenhouse Gas Reduction

Dust control can be achieved by reducing the spatial extents and amount of time that soils are exposed to construction activities. Reducing traffic speed and volume can also reduce dust concerns. Surface and air movement of smoke and dust during project activities can be mitigated through preventive measures and design criteria.

- Where suitable, exposed soils should be watered as required to suppress dust. Sediment-laden runoff water must not be conveyed to the storm drain system, off the project site, or over steep slopes. Oil and other petroleum products must not be used for dust suppression. Alternative dust suppressants must be approved by the EM prior to application.

- Idle time of construction equipment and contractor vehicles must be kept to a minimum to reduce the release of greenhouse gases. The contractor should inform and educate employees and sub-contractors on the importance of minimizing idling time and develop guidelines to direct the practice of reducing unnecessary idling.

- If possible, alternate energy sources should be considered during development of the site, such as solar panels and ground source heating and cooling. Other options for greenhouse gas reducing features include rainwater recycling systems, landscaping with native species, and utilizing water efficient products.

4.8 Environmental Monitoring

A suitably qualified environmental monitor (EM) is typically required by the District of Summerland to be retained during construction to document compliance with mitigation measures and provide guidance for implementation of best practices. If greater disturbance occurs due to unforeseen circumstances, the EM will recommend further measures to protect/restore the natural integrity of the site. The EM must be notified a minimum of 48 hours prior to initiation of construction works to schedule site visits.

- A pre-construction meeting must be held between the EM and the contractor(s) undertaking the work onsite to ensure a common understanding of the mitigation measures and best practices required for the project. At this time the location of erosion and sediment control measures will be reviewed.
- The EM will be an appropriately Qualified Environmental Professional (QEP) that will halt construction activities should an incident arise that is causing undue harm (unforeseen or from lack of due care) to terrestrial, aquatic or riparian resource values.
- Environmental monitoring is typically conducted on a minimum monthly basis for the duration of the construction works. However, this will be dependent on the nature of the works occurring, construction schedule, and District of Summerland DP requirements.
- A copy of the DP and this assessment report must be kept readily available at the site for reference while the work is being conducted.
- Summary monitoring reports will be completed on a regular basis (i.e., monthly) and submitted to the client, District of Summerland and appropriate contractors. A final report will be submitted upon substantial completion of construction and restoration works.
- Follow-up monitoring of restoration works will need to take place 1, 2, and 3 years post-completion to document adequate removal of non-native trees, establishment of grass seed, and successful invasive plant control/management. Ongoing maintenance will be recommended as required, with reports provided to the client, District of Summerland, and appropriate contractors. If disturbance occurs outside of the development footprint, additional restoration recommendations will be provided by the EM.

4.9 Anticipated Next Steps

At the time of the development permit, the following are items that should occur:

- A detailed environmental protection plan or construction environmental management plan should be prepared that updates and confirms specifics of the generic recommendations presented within this report.

- A formal restoration plan, that identifies the locations and extents of weed management and restoration should be prepared to accompany the development permit.

4.10 Bonding

Performance bonding is typically required by the District of Summerland to ensure the recommended compensation and restoration measures are completed and an EM is retained to document compliance with provincial guidelines and BMPs. Bonding in the amount of 125% of the estimated value of restoration works is required to ensure faithful performance and that all mitigation measures are completed and function as intended.

Performance bonds shall remain in effect until the District of Summerland has been notified, in writing, by the EM that the standards bonded for have been met and substantial completion of the works has been achieved. Table 7 outlines the proposed bonding amount for the recommended restoration within the subject property. The restoration focuses on the removal of non-native / invasive trees, weed management and grass seeding. Please note that this is a general estimate based on sourcing of materials and labour separately and based on communication with local landscapers/plant suppliers. This is only a basic estimate provided to estimate the required bonding and should not be used for development costing. A quote from a landscape/reclamation company which will handle most components of the works may prove to be more accurate. If a separate quote is prepared, it must be reviewed by Ecoscape prior to implementation.

Table 7. Bonding estimate for restoration work at subject property

Item	Total
Removal of non-native trees from Polygon 3	$15,000
Invasive Species Removal (initial and 3 year maintenance period)	$10,000
*Hydroseeding with tackifier of disturbed areas (resulting from proposed development works and invasive plant / tree removal) – estimated at 0.8 m^2 x 6,174 m^2	$4,940
Erosion and Sediment Control Measures	$2,000
Environmental Monitoring of restoration work (including a substantial completion report) and 3-year maintenance period. Note: this cost does not include EM during construction	$5,400
Total	**$37,340**

*Note: The area of 6,174 m^2 to be hydroseeded is a rough estimate and will have a finer resolution in the formal restoration plan.

Ecoscape estimates that the cost for the proposed monitoring, seeding, non-native tree / invasive species removal, erosion control, and substantial completion assessment will be approximately **$37,340**. A 125% bond in the amount of **$46,675** is recommended to meet the District of Summerland standards. Bonding for formal landscaping within the development area (around buildings/roadways) is not included in the bond estimate provided by Ecoscape.

5.0 CONCLUSION

This report summarizes the existing site conditions and natural areas within the study area and assesses the impacts that the proposed development may have on these values. This report also addresses the conditions of the District of Summerland ESDPA guidelines, as described in the District of Summerland OCP (Bylaw No. 2014 – 002),

The proposed development results in 63.5% of the study area being left undisturbed, while 36.5% will be disturbed with site development. The majority of the development occurs within Low and Moderate-value areas which have been subject to anthropogenic disturbance. This is with the exception of approximately 16.7 m^2 of High-value ESA which will be disturbed, this represents 0.1 % of the High-value ESA within the subject property. The impacted ESA 1 is directly adjacent to an ESA 3, and is likely closer to an ESA 2, than a true ESA 1. Based upon the site assessment and the client's general plan, the proposed development retains 99.9% of the High-value ESA (ESA 1) and 89 % of the Moderate-value (ESA 2) habitat.

Incorporation of the outlined best practices and recommended mitigation measures in the design and construction, as well as municipal and provincial regulations and best management practices will provide appropriate guidance in the development of avoidance, mitigation and/or compensation strategies for the sensitive habitats described in this report. Implementation of mitigation measures and environmental monitoring will reduce potential environmental and/or land use conflicts and identify opportunities for further restoration or enhancement activities in the future.

6.0 CLOSURE

This report has been prepared for the Lark Group with consideration for the existing and potential site conditions of the study area with respect to intrinsic ecological values, as well as the proposed land use of the area. Ecoscape has prepared this report with the understanding that all available information on the past, present, and proposed conditions of the site have been disclosed. Lark Group has acknowledged that in order for Ecoscape to properly provide the professional service, Ecoscape is relying upon full disclosure and accuracy of this information.

If you have any questions or comments, please contact the undersigned at your convenience.

Respectfully submitted,

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.

PREPARED BY:

Tina Deenik, B.Sc.
Junior Biologist
Direct Line: (250) 491-7337 ext. 217

REVIEWED BY:

Kyle Hawes, R.P.Bio.
Senior Natural Resource Biologist
Direct Line: (250) 491-7337 ext. 23

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Photo 1. View of the shrub steppe ecosystem, photo taken in the northeast corner of the subject property (all photographs taken March 16, 2017).

Photo 2. View of the non-native locust and elm trees disrupting the natural shrub steppe ecosystem.

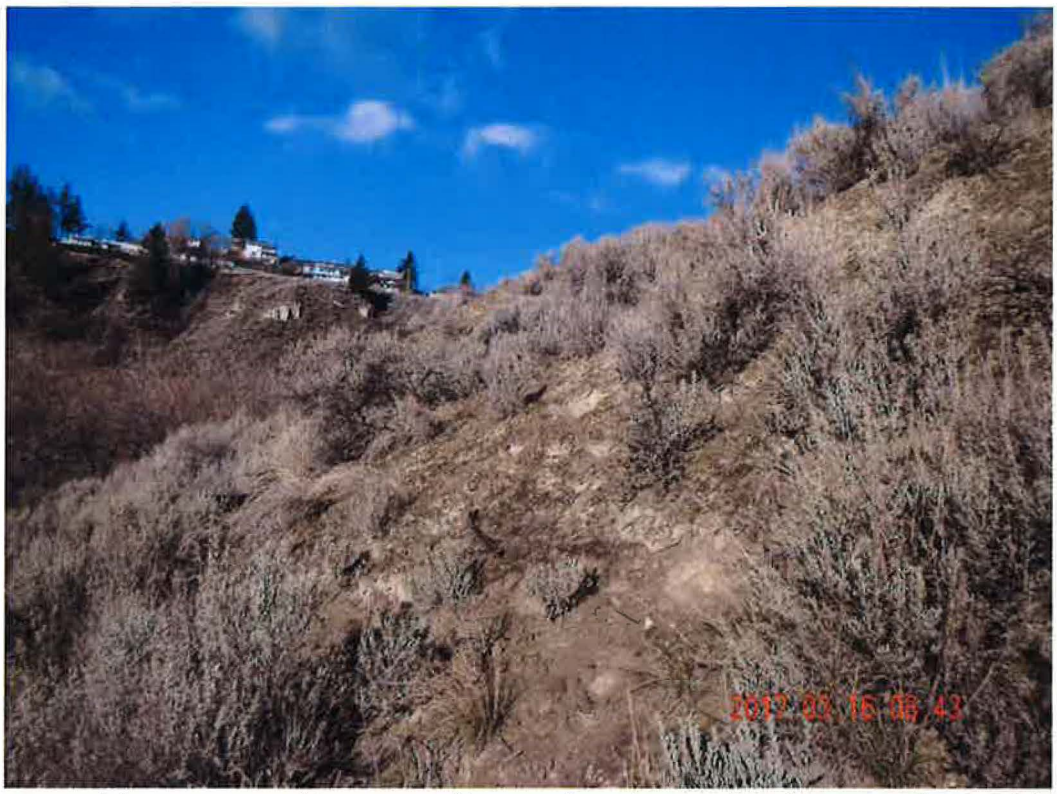


Photo 3. View of the cryptographic crust and bare soil sections within the upper slopes of the subject property.

Photo 4. Yard waste and associated invasive species located just north of the subject property adjacent to the property boundary.

Photo 5. View of the silt bluffs located along the northern boundary of the subject property.

Photo 6. Silver poplars disrupting the natural shrub steppe ecosystem along the northern boundary of the subject property.

Photo 7. Transition zone with the shrub steppe ecosystem to the viewer's right and the woodland, cool aspect ecosystem to the left. Douglas maple and Saskatoon are located in this drainage gully.

Photo 8. Some of the invasive species located within the subject property. Left to right: cleavers, Dalmatian toadflax, hounds tongue.

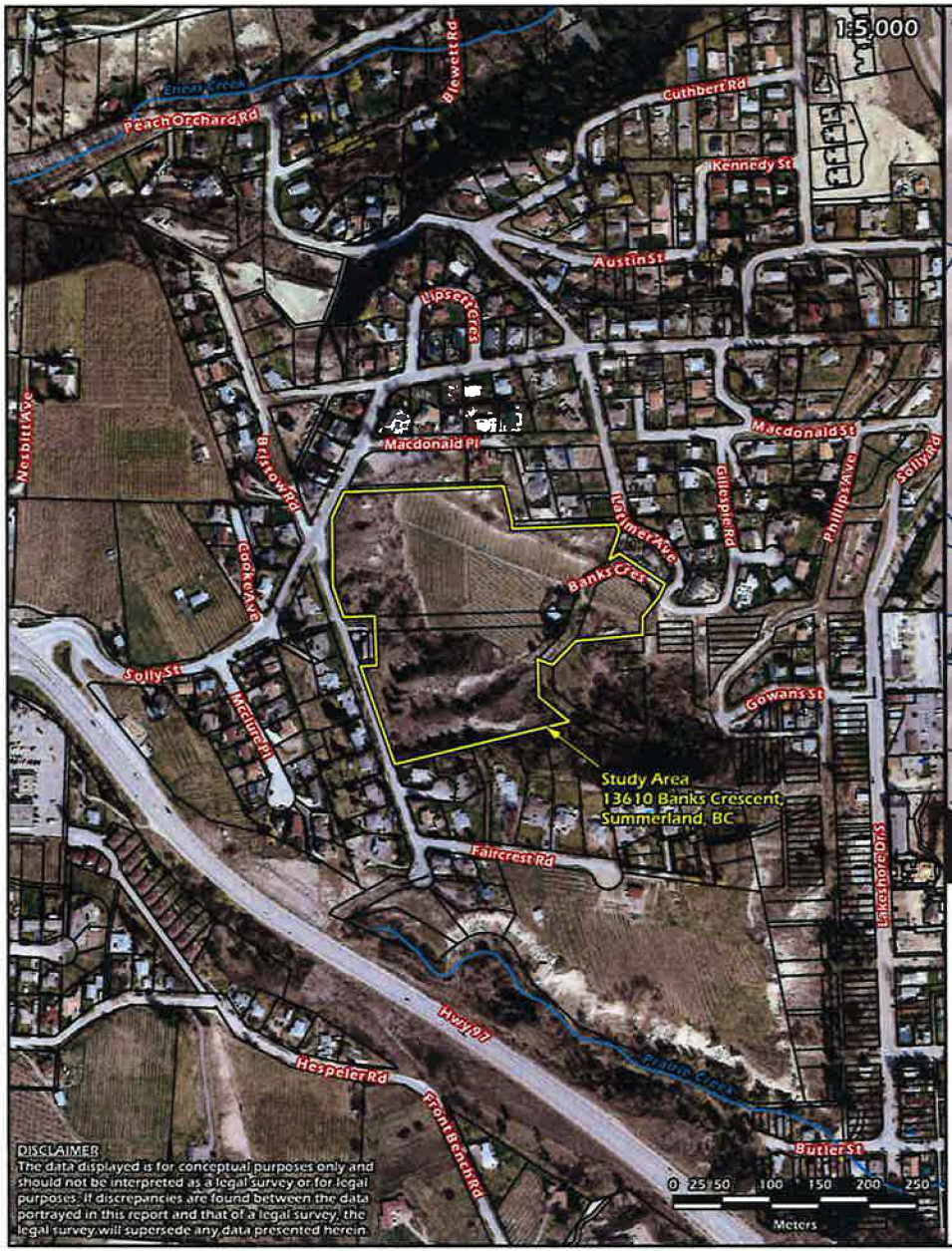
Photo 9. View of the cool aspect of the subject property characterized by ponderosa pine, moss and shrubs.

Photo 10. View looking north toward the shrub steppe ecosystem on the subject property and the vineyard below.

Photo 11. Bird foraging activity within silt bluffs (photo taken July, 2016).

Photo 12. One of many unused burrows located within the subject property. Based on the level of landscape fragmentation and shape of burrows, previous species use is assumed to have been marmot. This is corroborated by observations of adults in the early spring 2017 site visit.

FIGURES



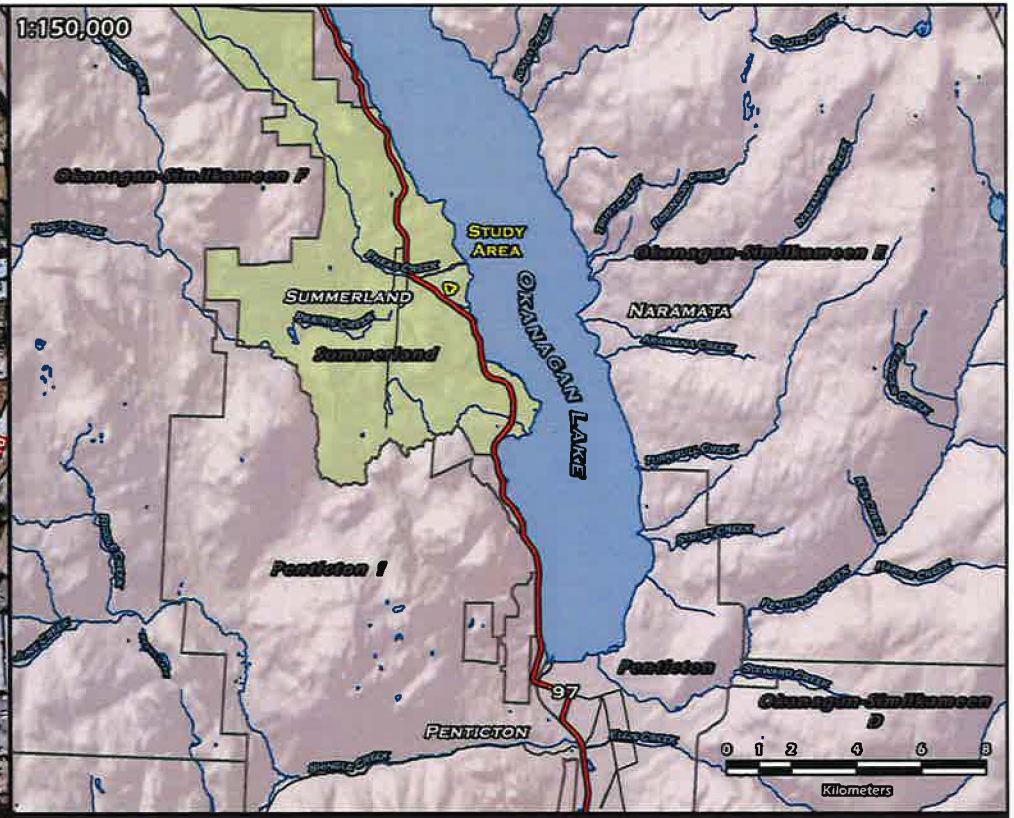


FIGURE 1

Site Location

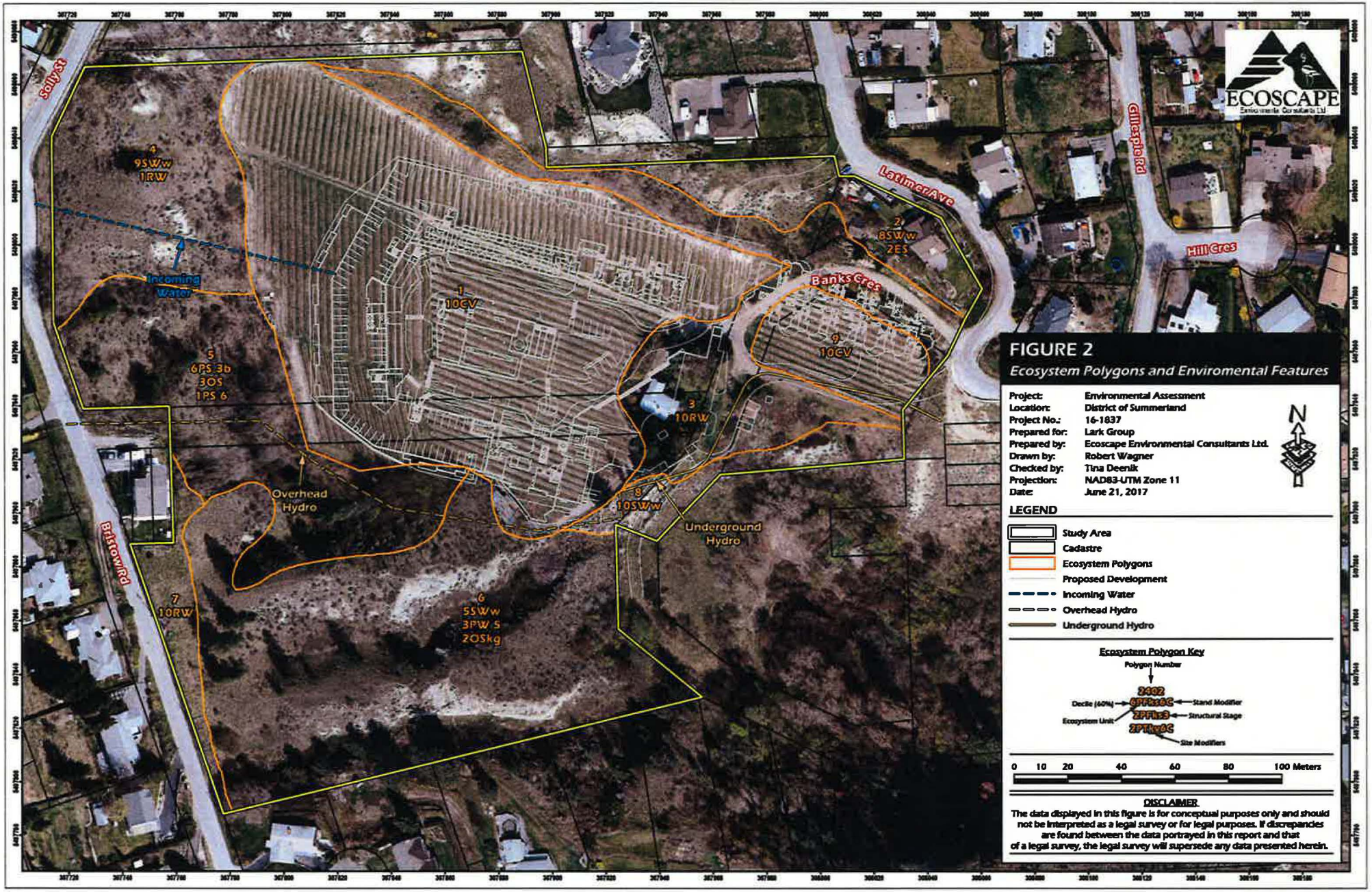
Project:	Environmental Assessment
Location:	District of Summerland
Project No.:	16-1837
Prepared for:	Lark Group
Prepared by:	Ecoscape Environmental Consultants Ltd.
Drawn by:	Robert Wagner
Checked by:	Tina Deenik
Projection:	NAD83-UTM Zone 11
Date:	June 21, 2017

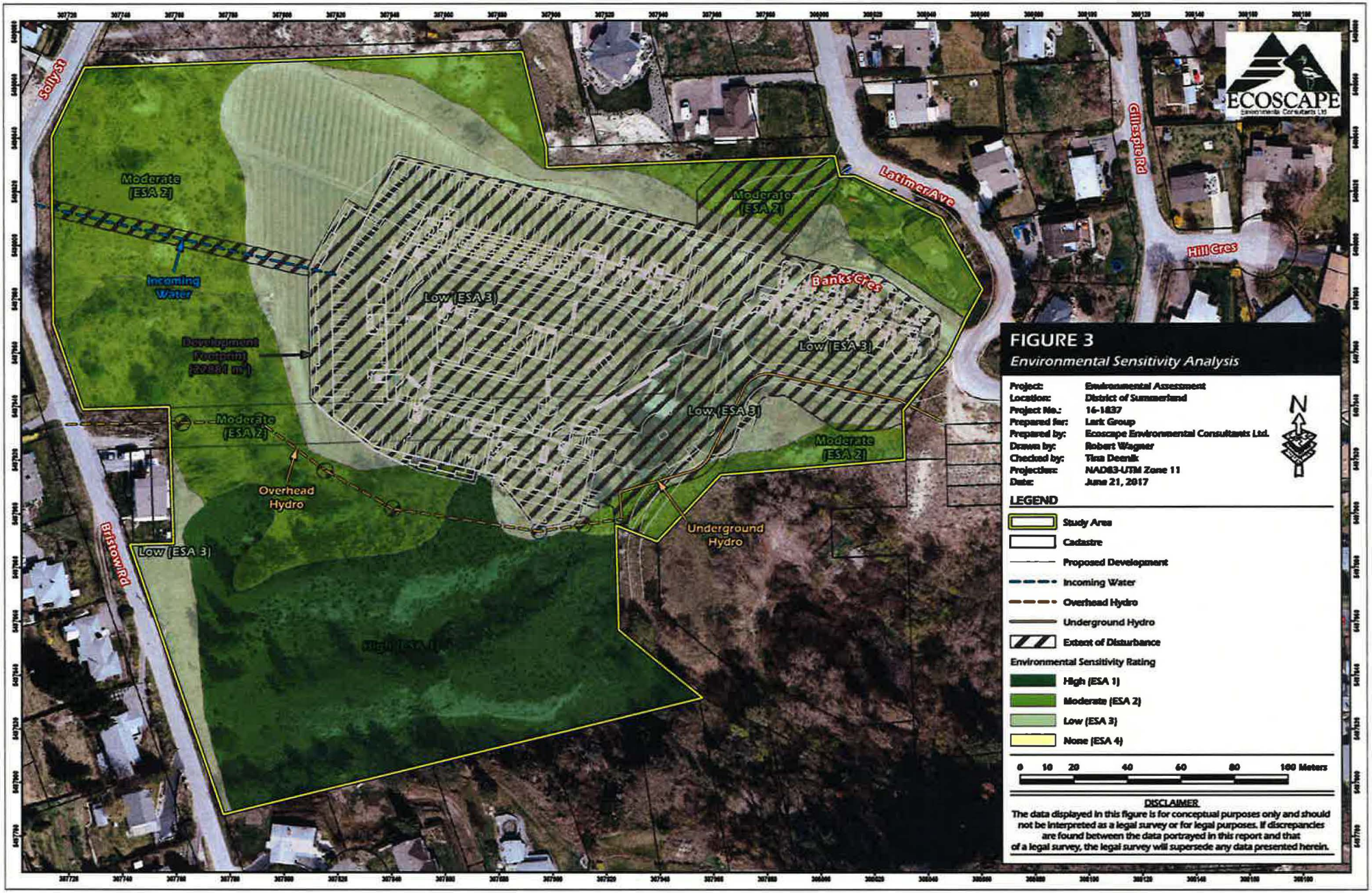
N

ECOSCAPE
Environmental Consultants Ltd.

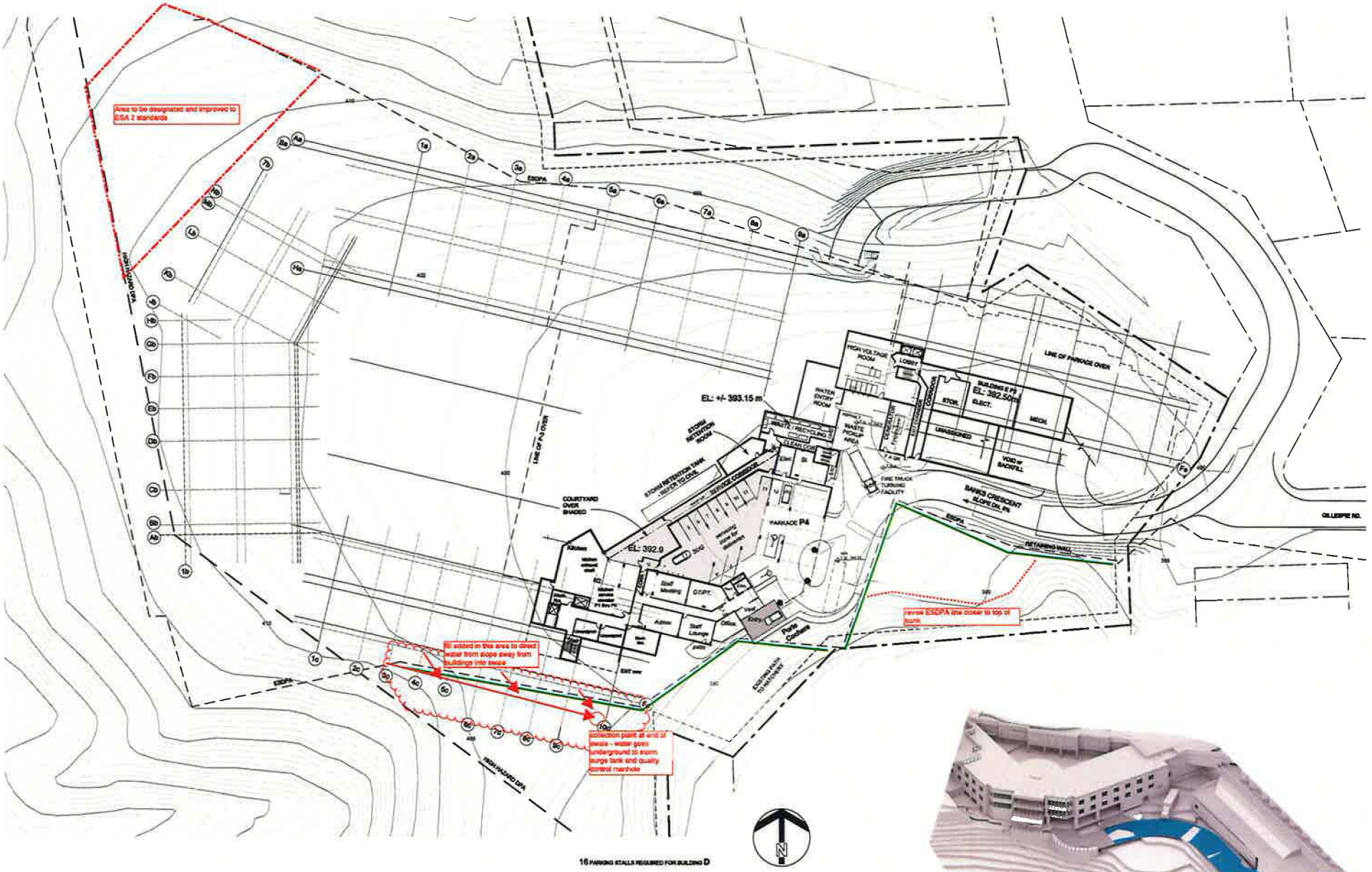
LEGEND

- Places
- Subject Property
- Major Highway
- Major Roads
- Municipal Boundary
- District of Summerland
- Study Area
- Cadastre
- Streams and Rivers
- Lake


Sally St
Briscow Rd
Latimer Ave
Gillespie Rd
Hill Cres
Banks Cres
Incoming Water
Overhead Hydro
Underground Hydro
4
9SWw
1RW
1
10CV
2
8SWw
2ES
3
10RW
5
6PS 3b
3OS
1PS 6
6
55Ww
3PW 5
20Skg
7
10RW
8
10SWw
9
10CV
ECOSCAPE
Environmental Consultants Ltd.
FIGURE 2
Ecosystem Polygons and Enviromental Features
Project: Environmental Assessment
Location: District of Summerland
Project No.: 16-1837
Prepared for: Lark Group
Prepared by: Ecoscape Environmental Consultants Ltd.
Drawn by: Robert Wagner
Checked by: Tina Deenik
Projection: NAD83-UTM Zone 11
Date: June 21, 2017
N
LEGEND
Study Area
Cadastre
Ecosystem Polygons
Proposed Development
Incoming Water
Overhead Hydro
Underground Hydro
Ecosystem Polygon Key
Polygon Number
2402
Decile (60%)
6PFbs6C
Stand Modifier
Ecosystem Unit
2PFbs3
Structural Stage
2PTbw6C
Site Modifiers
0 10 20 40 60 80 100 Meters
DISCLAIMER
The data displayed in this figure is for conceptual purposes only and should not be interpreted as a legal survey or for legal purposes. If discrepancies are found between the data portrayed in this report and that of a legal survey, the legal survey will supersede any data presented herein.


Solly St
Moderate (ESA 2)
Incoming Water
Development Footprint (32038 m²)
Moderate (ESA 2)
Overhead Hydro
Bristow Rd
Low (ESA 3)
High (ESA 1)
Low (ESA 3)
Moderate (ESA 2)
Low (ESA 3)
Low (ESA 3)
Moderate (ESA 2)
Underground Hydro
Banks Cres
Latimer Ave
Gillespie Rd
Hill Cres
ECOSCAPE
Environmental Consultants Ltd
FIGURE 3
Environmental Sensitivity Analysis
Project: Environmental Assessment
Location: District of Summerland
Project No.: 16-1837
Prepared for: Lark Group
Prepared by: Ecoscape Environmental Consultants Ltd.
Drawn by: Robert Wagner
Checked by: Tina Deerik
Projection: NAD83-UTM Zone 11
Date: June 21, 2017
N
LEGEND
Study Area
Cadastre
Proposed Development
Incoming Water
Overhead Hydro
Underground Hydro
Extent of Disturbance
Environmental Sensitivity Rating
High (ESA 1)
Moderate (ESA 2)
Low (ESA 3)
None (ESA 4)
0 10 20 40 60 80 100 Meters
DISCLAIMER
The data displayed in this figure is for conceptual purposes only and should not be interpreted as a legal survey or for legal purposes. If discrepancies are found between the data portrayed in this report and that of a legal survey, the legal survey will supersede any data presented herein.

APPENDIX A
Site Plan



CONSULTANT

dca DEREK CRAWFORD ARCHITECT Inc.
127 Rainbow Road, Salt Spring Island BC, V8K 2V5
T: 604.666.6370 F: 604.666.6371 E: info@dc-arch.ca W: www.dc-arch.ca

NO.	DATE	REVISION
6	2017-03-08	PRELIMINARY for CONSULTANT MEETING
5	2016-12-02	ISSUED FOR PM
4	2016-06-14	ISSUED FOR CLIENT REVIEW
3	2016-05-06	ISSUED FOR CLIENT REVIEW
2	2016-05-23	ISSUED FOR CLIENT REVIEW
1	2016-05-02	RE-ZONING

PROJECT:
iCasa
RESORT LIVING

CLIENT:
LARK GROUP
DEVELOP BUILD MANAGE

DRAWING TITLE:
P4 FLOOR PLAN
SCALE: 1/32"=1'-0"

A2.0

PITEAU ASSOCIATES
GEOTECHNICAL AND
WATER MANAGEMENT CONSULTANTS

SUITE 304 - 1912 ENTERPRISE WAY
KELOWNA, B.C.
CANADA - V1Y 9S9
TEL: +1.778.484.1777 / FAX: +1.604.985.7286

www.piteau.com

Our File: 3583-M003

August 14, 2017

Lark Enterprises Ltd.
Suite 1500
13737 – 96th Avenue
Surrey, BC V3V 0C6

Attention: Mr. Myron Dirks, Project Manager

Dear Sirs:

Re: Hydrogeological Update
Proposed ICASA Development at 13610 Banks Crescent, Summerland, BC

Further to your request, we provide the following comments regarding specific issues relating to the proposed ICASSA seniors housing project in Summerland. This letter is further to our original technical memo issued in July 2016 (3583-M001), and a hydrogeological update in January 2017 (3583-M002).

With respect to the August 3, 2017 RockGlen report, this report provides a geotechnical engineering review of potential groundwater impacts at the proposed development. We concur that the potential for vibration induced turbidity to migrate within the aquifer and impact the turbidity in Shaughnessy Springs is negligible. This conclusion is supported by the estimated maximum depth of 10 m to 12 m for the dissipation of vibration generated at ground surface, whereas the most shallow depth to groundwater at the east end of the site is in the order of 20 m. In this regard, we refer to the same technical reference as RockGlen, which is a 2000 paper by Kim & Lee entitled, "Propagation and Attenuation Characteristics of Various Ground Vibrations", derived from the journal Soil Dynamics and Earthquake Engineering.

Other construction activities are not expected to impact the aquifer in any way, however, our understanding is that the groundwater monitoring plan proposed by Piteau will be used during construction to alert the construction team if there are groundwater issues and allow for cessation of work should turbidity levels exceed a high-risk threshold. The monitoring plan provides for baseline (pre-construction) and ongoing water level and water quality monitoring in two dedicated monitoring wells on site during the construction phase of the project. The groundwater monitoring will proceed in conjunction with the erosion and sediment control plan (ESP), which will manage surface runoff quantity and quality during construction.

I trust that these comments are useful for your dialogue with the District of Summerland and the Freshwater Fisheries Society.

Yours truly,

PITEAU ASSOCIATES ENGINEERING LTD.

Remi J. Allard, M.Eng., P.Eng.
Principal Hydrogeologist

RJA/skn

REFERENCES

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D. 2002. Identifying and Quantifying Urban Recharge: A review. Hydrogeology Journal Volume 10, Issue 1, pp 143-152.

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Piteau Associates Engineering. January 2017. Hydrogeological Update (January 4, 2017 Meeting Summary) Technical Memo 3583-M002.

PITEAU ASSOCIATES
GEOTECHNICAL AND
HYDROGEOLOGICAL CONSULTANTS

SUITE 300 - 788 COPPING STREET
NORTH VANCOUVER, B.C.
CANADA - V7M 3G6
TEL: (604) 986-8551 / FAX: (604) 985-7286
www.piteau.com

MEMORANDUM

TO: Malek Tawashy
Development Project Manager
Lark Group

Our file: 3583-M002

Date: January 19, 2017

FROM: Matthew L. Cleary, P.Geo.
Email: mcleary@piteau.com

RE: Hydrogeological Update (January 4, 2017 Meeting Summary)
13610 Banks Crescent, Summerland, BC

INTRODUCTION AND BACKGROUND

Piteau Associates Engineering Ltd. (Piteau) was retained by the Lark Group in May 2016 to conduct a hydrogeological assessment addressing potential impacts to a nearby groundwater spring associated with construction of a proposed retirement and assisted living facility at the above referenced address (the Site). The findings of this assessment were presented in a memorandum dated July 12, 2016.

Working on behalf of Freshwater Fisheries Society BC (FFSBC), who utilize flow from Shaughnessy Spring (the Spring) to supply a nearby fish hatchery (the Hatchery), MDM Groundwater Consulting Ltd. (MDM) reviewed Piteau's July 12, 2016 memorandum. In an e-mail dated December 16, 2016 MDM reiterated the need for an erosion and sediment control plan (ESCP) and a groundwater monitoring plan (herein referred to as an environmental monitoring plan (EMP)) to be implemented during construction.

Development of ESCP documents is considered standard practice within the construction industry. As such, the development of an ESCP would have been conducted in the normal course of project development, with a specific focus on potential impacts to the Spring and the Hatchery. As per the request of FFSBC, CTQ and Piteau have developed concepts for an ESCP and an EMP, which were provided along with concept drawings to the Lark Group in December 2016.

A meeting (the Meeting) was held on January 4, 2017 to discuss the current status of the proposed development and preliminary plans plus concept drawings for the ESCP and EMP. The following persons were in attendance:

Malek Tawashy	Lark Group
Gary Tamblyn	New Essence Care Management
Kyle Girgan	Freshwater Fisheries Society BC
Matt Cameron	CTQ Consultants Ltd.
Matt Cleary	Piteau Associates Engineering Ltd.

Minutes from the Meeting were prepared by Mr. Malek Tawashy and made available for comment by meeting attendees and their respective organizations. In response, FFSBC outlined their outstanding concerns regarding construction related hazards and associated risks to the Spring water quality, specifically highlighting concerns regarding elevated turbidity and the possible release of contaminants during construction at the Site.

FFSBC CONCERNS AND ASSOCIATED ACTION ITEMS

This memorandum has been prepared to address the FFSBC's concerns. These are set out below, along with action items suggested by Piteau:

1) FFSBC emphasized that the magnitude and duration of events with elevated turbidity are equally important in assessing the risk to the Hatchery. While not currently defined, there would be a maximum turbidity level in the Spring, irrespective of the duration of the event, for which trout would not be able to survive.

   FFSBC is gathering information on the impacts of elevated turbidity on trout and will use this to further develop threshold criteria. These criteria will be included in the ESCP and EMP. In the event that an elevated turbidity event is observed during the construction period, a route cause analysis would be conducted to determine the cause(s) of the elevated turbidity.

   Action: FFSBC turbidity criteria to be included in the ESCP and EMP, as appropriate.

2) FFSBC indicated that there have been brief events (up to two hours duration) of high turbidity following historical precipitation events and that they were manageable. One such event was reported to have occurred in September 2015. The specific source(s) of the elevated turbidity (eg., sloughing of a portion of the slope above the Spring, and/or entrainment of sediment in overland flow) was not identified.

   Action: Review photographic documentation to help understand the cause of the September 2015 turbidity event.

3) As indicated by CTQ, a detailed spill response plan (SRP) would be included within the ESCP and EMP documentation. FFSBC has requested that the two existing monitoring wells (MW-1 and MW-2) be used to monitor groundwater quality during construction to provide early detection of potential impacts.

   It is important to note that the relatively thick layer of overlying finer-grained silt and clay (10 to 25 m) has low permeability and will impede vertical contaminant migration, thus resulting in a low risk to water quality at the Spring.

   Action: The SRP will be implemented in the event of releases of potentially hazardous substances on Site (eg., gasoline, diesel, hydraulic fluid and coolant). This would include recovery of spilled material and contaminated media, along with analysis of confirmation soil samples and groundwater and surface water monitoring.

4) FFSBC has indicated that monitoring wells MW-1 and MW-2 should be used to monitor potential vibration-induced turbidity within the aquifer, unless there is technical justification that disqualifies the monitoring wells for that purpose.

Under extreme conditions, vibration-induced turbidity may be generated within an aquifer by heavy machinery and trucks (live loads) operating at construction sites. Due to the depth to the water table at the Site (20 to 30 m below ground surface), it expected that the energy generated from construction activities will be dissipated.

Vibration-induced turbidity within the aquifer is expected to be orders of magnitude lower than that of erosion-induced turbidity on the Site and therefore the associated risk to water quality within the Spring is interpreted to be very low.

It is worth noting that groundwater sampling for turbidity within the aquifer is possible, although remnant turbidity within the wells may preclude them from providing useful turbidity data.

Action: No action recommended.

5) Erosion-induced turbidity within the Spring has two interpreted generation mechanisms, including mobilization of fine sediment during high precipitation events and the rapid release of material from the slope (sloughing). Erosion-induced turbidity is interpreted to be a higher risk to water quality. Such turbidity events result when high intensity precipitation events mobilize sediment-laden runoff.

To mitigate against impacts associated with erosion-induced turbidity generated from the slopes below the Site, tiered silt fencing will be constructed on the vegetated portion of the slope above the Spring. Timing for installation of these works will be conducted in coordination with FFSBC.

The risk associated with erosion-induced turbidity is significantly reduced with the implementation of a system of tiered silt fences that are properly installed, monitored and maintained. The current ESCP concept drawing (attached) provides details regarding the proposed silt fencing. Ultimately, the locations of the silt fencing will be agreed to with FFSBC. With the incorporation of silt fencing, the risk associated with erosion-induced turbidity is interpreted to be low.

Action: Incorporate above described measures in the ESCP.

6) As presented in the Piteau (2016) memo, the bottom level parkade slab elevations are between 398 and 404 m-asl. Based on the groundwater elevations in MW-1 and MW-2 (370.1 and 370.0 m-asl, respectively), the water table is at least 20 m below the parkade slab and therefore the proposed structures would not intersect or impede the natural groundwater flow system.

As confirmed by the Lark Group, the proposed development will neither withdraw groundwater from the aquifer for water supply nor dispose of water to the aquifer. In accordance with the MDM review email dated October 20, 2016, MDM concurred with the Piteau (2016) memo, concluding that the proposed development posed "no potential impact" to water quantity discharging to the Springs.

Action: No action recommended.

LIMITATIONS AND CLOSURE

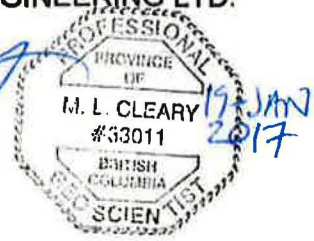
This memorandum has been prepared by Piteau for the Lark Group and reflects Piteau's best judgement based on the information available at the time of preparation. Any use that a third party makes of this report, or any reliance on or decisions based upon it, are the responsibility of such third parties. Piteau accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this report.

The findings, conclusions and recommendations in this report have been developed in a manner consistent with the level of skill normally exercised by environmental professionals currently practicing under similar conditions in British Columbia. No warranty is expressed or implied.

We trust this memorandum is sufficient for your current needs. Please contact the undersigned if you require further information.

Respectfully submitted,

PITEAU ASSOCIATES ENGINEERING LTD.



Matthew L. Cleary, P.Geo.
Senior Hydrogeologist

Reviewed by:

Remi J.P. Allard, P.Eng.
Principal Hydrogeologist

MLC/RJPA/DJT/lm

Att.

1. Construction Erosion and Sediment Control Plan, CTQ (January 17, 2016)

CONSTRUCTION EROSION AND SEDIMENTATION CONTROL PLAN
KEY POINTS:

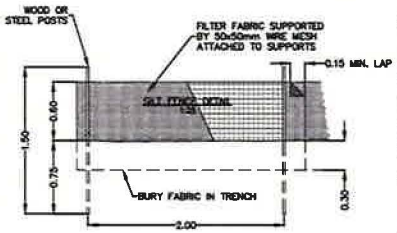
SURFACE STORM WATER RUNOFF IS CAPTURED AND DIRECTED TOWARDS THE WEIR INTERCEPTOR BY WAY OF THE INTERCEPTOR DITCH. FILTRATION AND TREATMENT OCCURS AT THE WEIR PRIOR TO BEING DISCHARGED DIRECTLY INTO THE MUNICIPAL STORM SYSTEM BYPASSING THE HATCHERY.

A CONTINGENCY BERM AND SILT FENCING INSTALLED ALONG THE SOUTH EAST PERIMETER OF THE SITE WOULD CAPTURE AND FILTER SURFACE RUNOFF AS REQUIRED.

SIMILAR BERM AND SILT FENCING DETAILED WILL BE INSTALLED IN A TIERED FASHION AT THE HEAD OF THE SPRING, PROVIDING PROTECTION FROM NATIVE EARTH THAT PRESENTS A RISK OF SLOUGHING INTO THE WATER SOURCE.

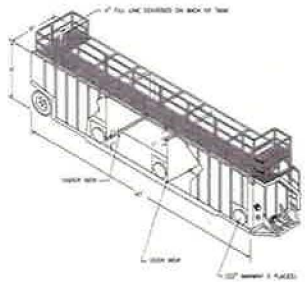
ONGOING REVIEW AND MAINTENANCE OF ALL INSTALLATIONS WILL BE CONDUCTED ON A REGULAR BASIS AND AFTER EACH RAINFALL EVENT. (AS PER NOTE 8.)

A "Spill Containment Plan" is to be prepared prior to the start of construction outlining the procedures to be undertaken in the event of a spill including but not limited to emergency response, procedures to mitigate and protect, notification and communications, reporting and documentation

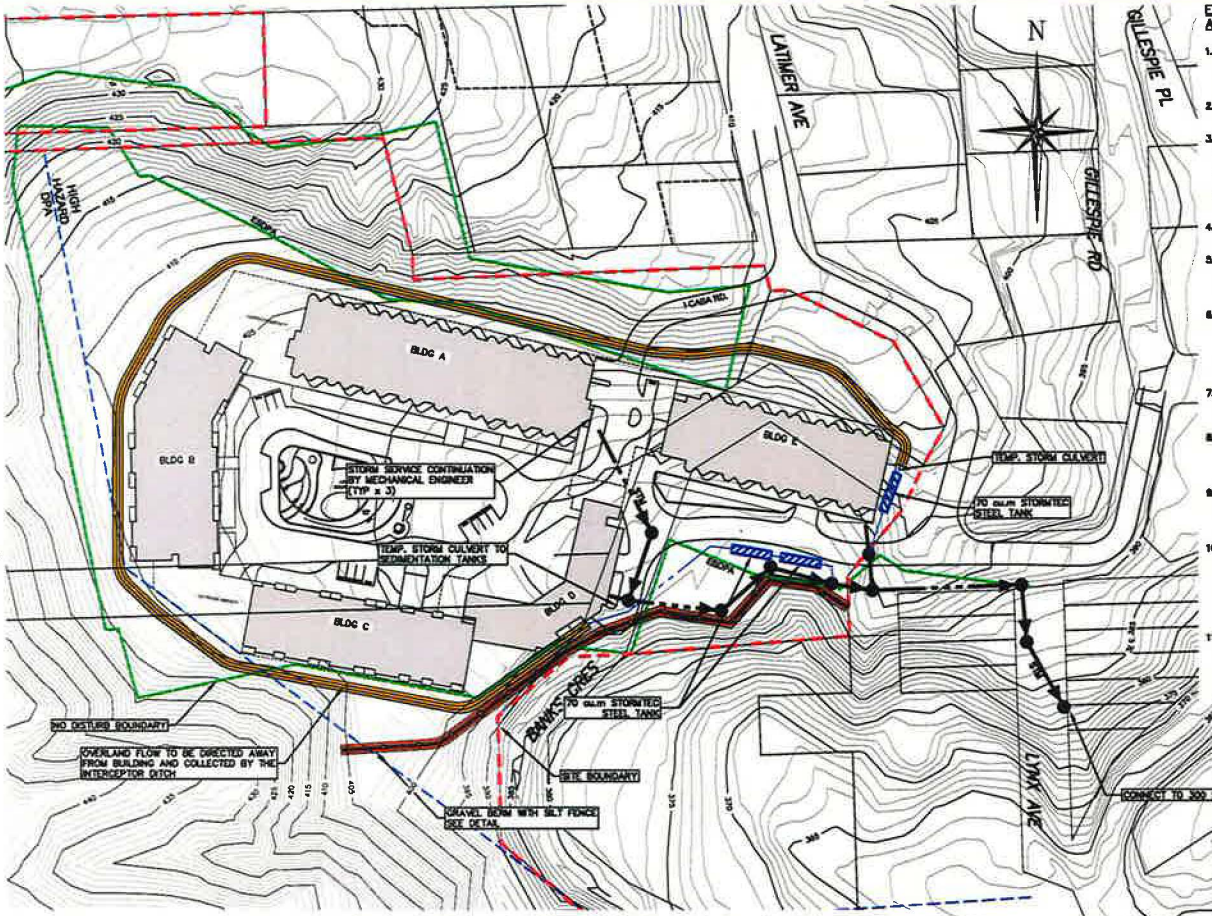


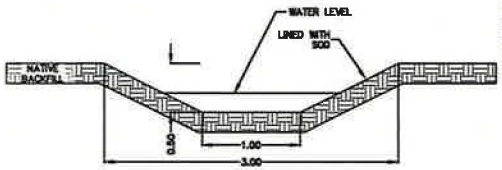
NOTES:

1. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.
2. SEDIMENT MUST BE REMOVED FROM SILT FENCE WHEN IT REACHES APPROXIMATELY ONE-THIRD THE HEIGHT OF THE FENCE AND DEPOSIT OFF-SITE.
3. SILT FENCE TO BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
3. THE SILT FENCE TO BE REMOVED ONCE THE SITE IS STABILIZED.
4. FOR FURTHER DETAILS SEE CITY OF KELOWNA 'BEST MANAGEMENT PRACTICES OF EROSION AND SEDIMENT CONTROL – UPLAND WORKS'



STORMTEC OPEN-TOP WEIR STEEL TANK
N.T.S.





INTERCEPTOR DITCH DETAIL
1:25

EROSION AND SEDIMENT MANAGEMENT NOTES – ALL STAGE OF CONSTRUCTION

1. ALL WORK IS TO BE UNDERTAKEN AND COMPLETED BY THE CONTRACTOR IN SUCH A MANNER AS TO PREVENT THE RELEASE OF SILT, SEDIMENT, OR ANY OTHER DELETERIOUS SUBSTANCES INTO ANY STORM SEWER OR WATERCOURSE.
2. ALL EXISTING CATCH BASINS ON SITE TO HAVE FILTER FABRIC INSTALLED PRIOR TO ANY WORK STARTING.
3. TO PREVENT EROSION:
   - 3.1. PREVENT CONCENTRATED OVERLAND FLOWS FROM OCCURRING
   - 3.2. COVER STOCKPILES, EXPOSED EARTH AND DISTURBED AREAS WITH TARP OR ANY APPROVED PRODUCT.
   - 3.3. LIMIT CLEARING AS MUCH AS POSSIBLE TO AREAS TO BE IMMEDIATELY WORKED.
4. PREVENT WIND BLOWN EROSION BY WATERING, COVERING EXPOSED EARTH OR BY OTHER APPROVED MEASURES.
5. EROSION & SEDIMENT MANAGEMENT WORKS SHALL BE INSTALLED BY THE CONTRACTOR PRIOR TO ANY WORK IN THE AREA FOR WHICH THE EROSION & SEDIMENT MANAGEMENT WORKS ARE INTENDED INCLUDING REMOVALS, CLEARING AND EARTHWORKS.
6. ALL EROSION & SEDIMENT MANAGEMENT WORKS TO BE MAINTAINED BY THE CONTRACTOR AT ALL TIMES TO ASSURE PROPER OPERATIONS. REPLACEMENT OF SILT FENCES AND FILTER CLOTHS (CATCH BASINS), THE FLUSHING OF SEWERS AND CLEANING OF SUMPS ARE REQUIRED DURING THE COURSE OF CONSTRUCTION.
7. REMOVE AND DISPOSE OF ACCUMULATED SEDIMENT FROM SEDIMENT MANAGEMENT FACILITIES BEFORE SEDIMENT REACHING ONE THIRD OF THE HEIGHT OF THE FACILITY.
8. MONITOR EROSION AND SEDIMENT MANAGEMENT WORKS DAILY AND AFTER HEAVY RAINFALL OR SNOW MELT EVENTS. ENSURE INSPECTIONS AREA COMPLETED AT END OF WORK WEEK OR HOLIDAYS.
9. PRIOR TO CONSTRUCTION ACTIVITIES, CONTRACTOR TO INSPECT ALL CATCH BASINS TO ENSURE FILTER FABRIC IS SECURE AND CLEAN OF DEBRIS TO PREVENT SEDIMENT FROM ENTERING ANY STORM SYSTEM.
10. DURING CONSTRUCTION THE CONTRACTOR IS TO FLUSH AND CLEAN STORM SYSTEM AS REQUIRED AND AT THE COMPLETION OF THE PROJECT. THE CONTRACTOR MAY NEED TO EMPLOY ADAPTIVE MEASURES, AND/OR ADDITIONAL MEASURES, AND/OR ADJUST THE INSTALLED EROSION AND SEDIMENT MANAGEMENT WORKS TO PREVENT THE RELEASE OF SEDIMENT LADEN WATER AS SITE CONDITIONS CHANGE.
11. ALL EROSION AND SEDIMENT MANAGEMENT WORK ARE TO REMAIN IN PLACE UNTIL ALL BUILDING ACTIVITIES ARE 80% COMPLETE AND UNTIL VEGETATION HAS DEVELOPED ON EXPOSED AND DISTURBED AREAS WHICH CONTRIBUTE FLOWS TO EROSION AND SEDIMENT MANAGEMENT WORKS.

SUMMERLAND
INDEPENDENT AND ASSISTED LIVING
EROSION AND SEDIMENT CONTROL PLAN
PROJECT No.16028
DRAWING No.SK-06
SCALE 1:1500
December 23, 2016

CTQ

PITEAU ASSOCIATES
GEOTECHNICAL AND
HYDROGEOLOGICAL CONSULTANTS

SUITE 300 - 788 COPPING STREET
NORTH VANCOUVER, B.C.
CANADA - V7M 3G6
TEL: (604) 986-8551 / FAX: (604) 985-7286
www.piteau.com

MEMORANDUM

TO: Malek Tawashy
Development Project Manager
Lark Group

Our file: 3583-M001

Date: July 12, 2016

FROM: Matthew L. Cleary, P.Geo.; Remi Allard, P.Eng.
Email: mcleary@piteau.com; rallard@piteau.com

RE: Hydrogeological Assessment – 13610 Banks Crescent, Summerland, BC

Piteau Associates Engineering Ltd. (Piteau) were retained by the Lark Group to conduct a hydrogeological assessment for a proposed retirement and assisted living facility located at 13610 Banks Crescent, Summerland, BC (the Site). This assessment was conducted in response to the June 17, 2016 letter[1] from the District of Summerland (the District), which stated the following:

"As this property is located in an area with known underground water streams that are utilized by the Freshwater Fisheries Society of BC a hydrogeological report is required to provide comment on any potential impact to the groundwater system.

- Action Required: Provide a Hydrological Assessment Report confirming the impacts of the proposed development on the existing groundwater system specifically how the natural ground water source that feeds the fish hatchery will be protected from impact."

SCOPE OF WORK

In accordance with the aforementioned requirements detailed by the District, the scope of work for this assessment included the following items:

- Drill eight test holes to assess soil and groundwater conditions at the Site;
- Install monitoring wells within two of the eight test holes;
- Monitor groundwater elevations in two monitoring wells;
- Collect groundwater samples from one monitoring well;
- Interpret groundwater flow direction at the Site;
- Characterize and compare groundwater and surface water chemistry; and
- Summarize groundwater conditions, including identifying any potential groundwater and surface water impacts associated with the proposed development, while providing recommendations for mitigating risk as needed.

[1] District of Summerland, 2016.

The hydrogeological drilling program was conducted in conjunction with the geotechnical drilling program. Rock Glen Consulting Inc. (RGC) supervised the drilling program, logged soils and monitored the installation of two monitoring wells. A Piteau hydrogeologist was present during of drilling at MW-1 and MW-2, to identify the approximate depth to groundwater, and provide recommendations for monitoring well installation.

BACKGROUND INFORMATION

The Site is located approximately 50m northwest of a system of springs collectively known as Shaughnessy Springs, which supply water to the Summerland Trout Hatchery (the Hatchery; Fig. 1). The Hatchery operates under two surface water licenses referenced as C069506 and C069507, with permitted quantities of 1 and 2 ft^3/s (28.3 and 56.6 L/s), respectively. Shaughnessy Springs has a relatively consistent flow of about 2,800 L/min (47 L/s) according to Mr. Kyle Girgan, Hatchery Manager, Freshwater Fisheries Society of BC (FFSBC). A historical range of flow between 2,650 and 3,400 L/min (44 and 57 L/s) was reported in the groundwater availability assessment report prepared by Golder[2] (2004) for FFSBC.

The Golder (2004) report indicated a groundwater elevation of about 369 m-asl (metres above sea level) at the Upper Shaughnessy Spring (Fig. 1).

BC Ministry of Environment (MOE) collected 57 water samples from Shaughnessy Springs for various parameters between 1973 and 1984; the results of which were presented in a BC MOE (1985) memorandum[3]. Concentrations of total nitrogen ranged from 4.34 to 6.76 mg/L, and averaged 5.38 mg/L. Total nitrogen for the October 4, 1984 sample measured 7.1 mg/L (NO_2 + NO_3). Concentrations continually rose during this period and indicate some form of anthropogenic nitrate source located upstream (i.e., residential septic fields or agricultural applications).

A subsequent report prepared by BC MOE[4] (1986) indicated that the maximum nitrate concentration should not exceed 40 mg/L, with an "alert" level of 13 mg/L. It was proposed that if/when nitrate concentrations consistently exceed 13 mg/L, appropriate measures should be taken to correct the situation or determine if a real concern exists for the water supply.

SITE GEOLOGY

Eight test holes (TH-1 to TH-8) were drilled by Mud Bay Drilling Ltd. between June 13 and 16, 2016, to characterize soil and assess groundwater conditions at the Site. Geology within the test holes was logged by RGC and presented on test hole logs in the RGC[5] (2016) draft geotechnical report. The test holes were drilled to depths ranging from 8.2 to 38.1 m-bgs (metres below ground surface), with the two deepest locations (TH-1/MW-1 and TH-2/MW-2) drilled at the eastern edge of the Site.

---

[2] Golder Associates, 2004. "Initial Phase – Groundwater Availability Assessment, Summerland Trout Hatchery, Summerland, BC". Report prepared for Freshwater Fisheries Society of BC, 21 pgs., October.
[3] BC Ministry of Environment, 1985. "Summerland Trout Hatchery; File: 82 E/12 #25", 6 pgs., April 16.
[4] BC Ministry of Environment, 1986. "Assessment of Water Resources at Summerland Hatchery; File: 82 E/12 #25", 66 pgs., June 10.
[5] Rock Glen Consulting Ltd., 2016. "DRAFT – Geotechnical Assessment for Proposed Summerland Independent & Assisted Living Development – 13610 Banks Crescent, Summerland." Report prepared for The Lark Group, 4 pgs., July 7.

In general, the Site geology consists of fine-grained lacustrine silt and clay sediments overlaying coarser-grained alluvial sand and gravel sediments. Relatively thin layers of coarser sand and gravel were encountered within the finer-grained lacustrine unit, although these thin layers did not indicate saturated aquifer conditions. The lacustrine sediments were encountered to a depth of between 3.3 to 24.4 m-bgs, although test holes TH-3 to TH-8 were only drilled to a maximum depth of 11.3 m-bgs. Therefore, the alluvial sediments that were encountered at shallower depths could have represented thinner layers within the thicker lacustrine unit.

SITE HYDROGEOLOGY

Test holes TH-1 and TH-2 (also referenced as MW-1 and MW-2) were both completed as monitoring wells using 50mm nominal diameter schedule 40 PVC. Monitoring well MW-1 was screened from 30.8 to 36.9 m-bgs, while MW-2 was screened from 24.4 to 29.0 m-bgs. Each screen interval was completed using 0.010" (10-slot) PVC and a 10-20 sand filter pack. Bentonite seals (0.6m thick) were placed every 6.0m over the length of each test hole, and completed with concrete plus a lockable stick-up cover at surface.

Upon completion of drilling, Piteau returned to Site on June 21, 2016, to measure water levels in each monitoring well and collect groundwater samples from MW-1. Depths to water at MW-1 and MW-2 were 32.0 and 21.2 m-toc (metres below top of casing). A geodetic survey of the eight test holes was conducted by Mandeville Land Surveying Inc., which allowed conversion of water levels to geodetic elevations. Resulting water level elevations for MW-1 and MW-2 were 370.1 and 370.0 m-asl, respectively. These water levels were used in combination with the elevation at Upper Shaughnessy Spring (369 m-asl) to calculate a south-southeast flow direction with a hydraulic gradient of 0.02 m/m.

Groundwater samples were submitted to Caro Analytical Services for analysis of physical parameters, nutrients, anions, cations, and dissolved metals. Similar parameters were collected from Shaughnessy Springs by FFSBC on June 1, 2016 and submitted to Maxxam Analytics. Original laboratory reports for both surface water and groundwater are presented in Appendix A.

A tri-linear plot was constructed to present the percentages of major anions and cations for both MW-1 and Shaughnessy Springs (Fig. 2). The results of this plot indicate a strong correlation between both samples, indicating that groundwater at MW-1 and Shaughnessy Springs have the same provenance (source water). Water from both samples is classified as calcium bicarbonate type.

The concentration of nitrate (as N) at Shaughnessy Springs was reported at 3.83 mg/L, while the reported concentration at MW-1 was 6.17 mg/L. Both of these concentrations are below the previously referenced "alert" level and within the range of historical concentrations reported for Shaughnessy Springs.

Total suspended solids (TSS) at Shaughnessy Springs for the June 1, 2016 sampling event had a reported concentration of <4.0 mg/L. This value can be used as a baseline surrogate for turbidity.

POTENTIAL GROUNDWATER IMPACTS AND MITIGATIVE MEASURERS

Potential impacts to groundwater associated with the proposed development at the Site are anticipated to be limited as discussed below.

Constituents of concern generated on Site that could potentially include nitrate and persistent pharmaceuticals within liquid waste water, as well as turbidity generated from storm water run-off. As indicated in the CTQ Consultants Ltd. (CTQ) memorandum[6], it is understood that the proposed development would connect to the existing District sanitary sewer collection system and therefore any potential impact associated with liquid waste water is considered low.

It is understood that the District currently has no storm drainage system, and therefore storm water generated at Site would be captured, stored and then released to the natural drainage course. Part of the proposed storm water management plan presented in the CTQ memorandum included a 150 m^3 storage tank and a flow control manhole, which allows for a maximum release rate of 148 L/s (pre-development ten-year storm event equivalent). Topography in the area naturally drains to the east, towards Shaughnessy Springs, and therefore there is a moderate risk associated with elevated turbidity generated during higher precipitation storm events at the Site. The focused discharge of storm water associated with a 1:10 year event could result in elevated turbidity observed at Shaughnessy Springs. To mitigate the potential risk associated with elevated turbidity, it is recommended that a natural infiltration gallery be constructed at the discharge point within the natural drainage course. Such a gallery would combine a surficial layer of rip rap with underlying layers of sand oriented as a reverse-graded filter. This design would dissipate the energy associated with higher release rates and therefore decrease the potential for increased turbidity. Turbidity would further be filtered through the reverse graded filter.

Depth to groundwater was observed between about 20 and 30 m-bgs at the two monitoring wells located at the east edge of the Site. The depth to water follows a subdued replica of surface topography and therefore the depth to groundwater in western portions of the Site is expected to be 1-2m deeper. As per email communications with Mr. Malek Tawashy[7], proposed bottom level parkade slab elevations are between 398 and 404 m-asl. This range of elevations is likely at least 20m above the water table and therefore the proposed structures would not intersect or impede the natural groundwater flow system.

Any decrease in infiltration associated with proposed buildings and road cover would be conveyed to the storm water system and discharged to the natural drainage course as mentioned above. Discharged flow may actually increase as there will be a reduction in the total water loss to evapotranspiration, while magnitudes of storm water discharge to the natural drainage course will likely be higher in magnitude and potentially shorter in duration.

Therefore, the potential for flow quantity in Shaughnessy Springs to be negatively impacted by the proposed development is considered low.

---

[6] CTQ Consultants Ltd., 2016. "Summerland Independent and Assisted Living – Concept Servicing Memo", 4 pgs., May 19.

[7] Tawashy, M., 2016. Email communications – "RE: Summerland Independent & Assisted Living Development", June 10.

During construction of the proposed development, heavy truck traffic combined with exposed soils presents a risk to water quality within the Shaughnessy Springs. Potential impacts and mitigative measures that should be considered detailed as follows:

- Elevated turbidity in surface runoff – To reduce the impacts of high turbidity during construction, silt fencing should be installed at the eastern extents of the Site and surface runoff should be directed to a series of sedimentation ponds prior to discharge to the natural drainage course;
- Air quality (Dust) – Dust generated during construction could settle within the catchment and result in elevated turbidity within Shaughnessy Springs. It is therefore recommended that dust suppression measures be considered; and
- Vibration-induced turbidity – The movement of heavy trucks at the eastern portion of the Site would likely result in increased ground vibrations potentially resulting in the mobilization finer-grained sediments within the aquifer. As the aquifer is the interpreted source of water for Shaughnessy Springs, it is expected that any mobilized sediment could potentially increase turbidity without sufficient time to be filtered through the remainder of the aquifer. If possible, an access point at the western edge of the Site should be considered to reduce the vibrations at the eastern side of the Site associated with truck traffic.

While potential impacts associated with construction are considered short-term concerns, it represents a higher potential risk to water quality within Shaughnessy Springs. A turbidity monitoring program may also be prudent and should be developed in conjunction with FFSBC.

LIMITATIONS AND CLOSURE

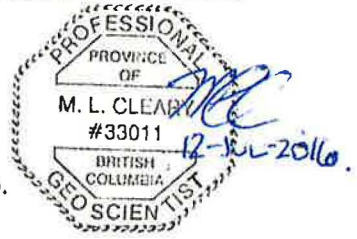
This report has been prepared by Piteau for the Lark Group and reflects Piteau's best judgement based on the information available at the time of preparation. Any use that a third party makes of this report, or any reliance on or decisions based upon it, are the responsibility of such third parties. Piteau accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this report.

The findings, conclusions, and recommendations in this report have been developed in a manner consistent with the level of skill normally exercised by environmental professionals currently practicing under similar conditions in British Columbia. No warranty is expressed or implied.

We trust this report is sufficient for your current needs. Please contact the undersigned if you require further information.

Respectfully submitted,

PITEAU ASSOCIATES ENGINEERING LTD.



Matthew L. Cleary, P.Geo.
Senior Hydrogeologist

Reviewed by:

Remi J.P. Allard, P.Eng.
Principal Hydrogeologist

MLC/slc

Att.

FIGURES

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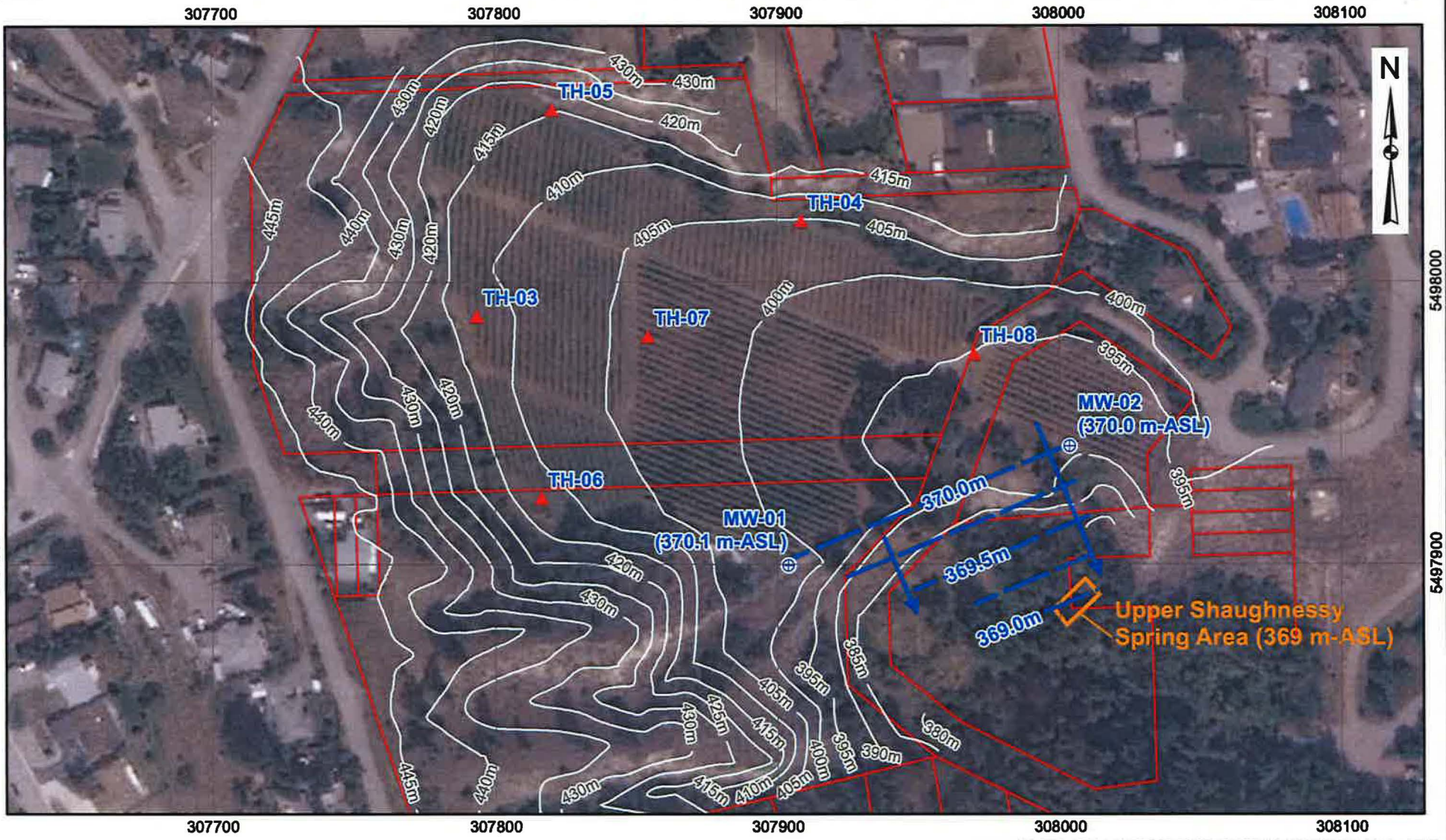

LEGEND

- ▲ Test Hole
- ⊕ Monitoring Well

0 25 50 75 100 m

SCALE: 1:2,000

LARK GROUP
HYDROGEOLOGICAL ASSESSMENT
13610 BANKS CRESCENT, SUMMERLAND, BC

PITEAU ASSOCIATES
GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

TEST HOLE AND MONITORING WELL LOCATION PLAN

BY:	DATE:
MLC	JUL 16
APPROVED:	FIG:
RJPA	1

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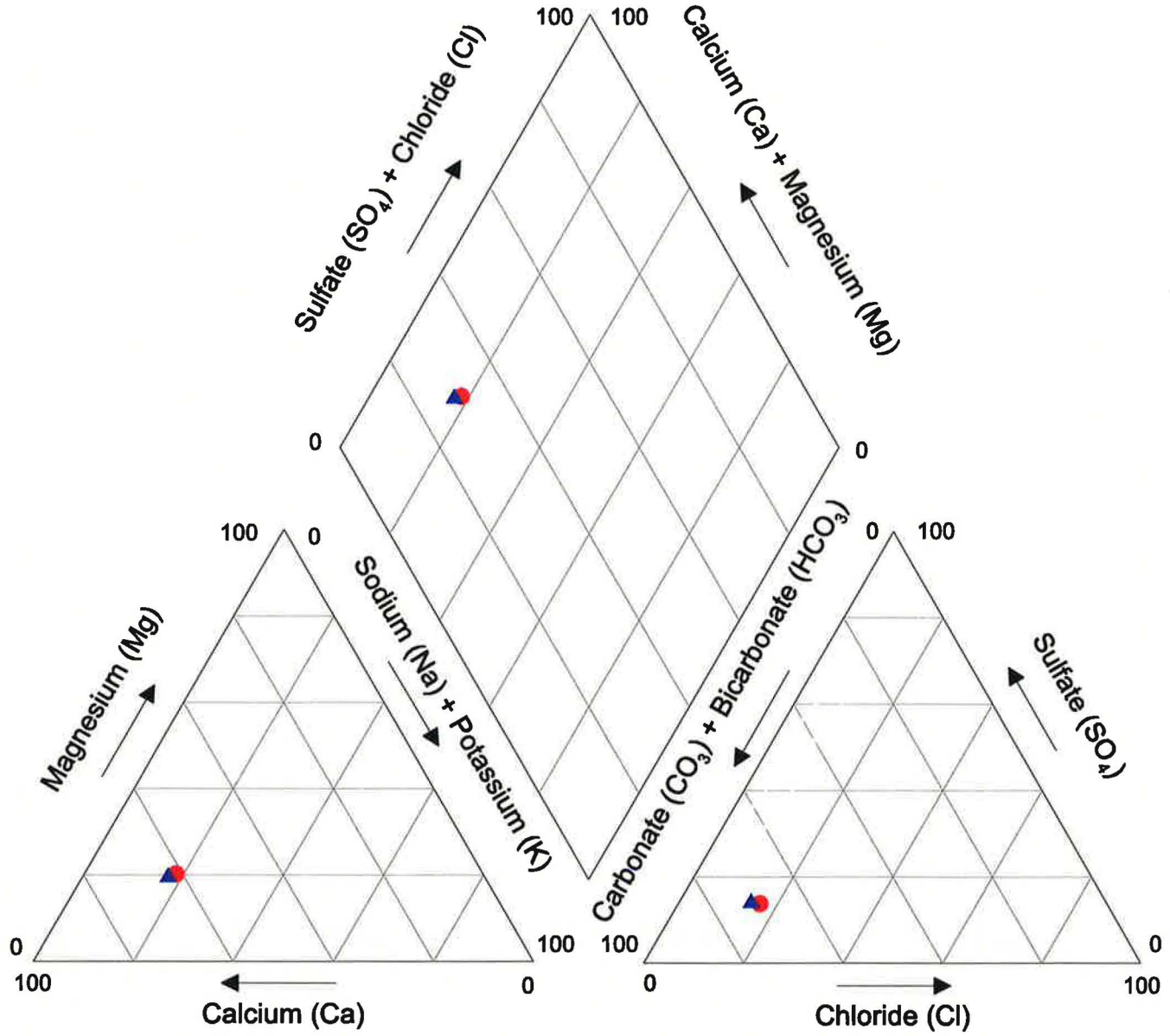

LARK GROUP
HYDROGEOLOGICAL ASSESSMENT
13610 BANKS CRESCENT, SUMMERLAND, BC

PITEAU ASSOCIATES
GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

TRI-LINEAR PLOT OF GROUNDWATER AND SURFACE WATER CHEMISTRY

BY:	DATE:
MLC	JUL 16
APPROVED:	FIG:
RA	2

APPENDIX A

LABORATORY ANALYTICAL REPORTS

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Piteau Associates Engineering Ltd. (Kelowna) #304 - 1912 Enterprise way Kelowna, BC V1Y 9S9	**TEL** **FAX**	(778) 484-1777 (778) 484-3901
ATTENTION	Matt Cleary	**WORK ORDER**	6061747
PO NUMBER		**RECEIVED / TEMP**	2016-06-21 15:24 / 14°C
PROJECT	3583	**REPORTED**	2016-06-29
PROJECT INFO	Summerland	**COC NUMBER**	B40038

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

This is a revised report. Refer to Appendix 3 for details

Revision 1 - Please note the change in sample ID as per client's request - SG

Authorized By: **Ed Hoppe, B.Sc., P.Chem.**
Division Manager, Kelowna

If you have any questions or concerns, please contact your Account Manager:
Sara Gulenchyn, B.Sc, P.Chem. (sgulenchyn@caro.ca)

CARO ANALYTICAL SERVICES

ANALYSIS INFORMATION

REPORTED TO	Piteau Associates Engineering Ltd. (Kelowna)	**WORK ORDER**	6061747
PROJECT	3583	**REPORTED**	2016-06-29

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Ammonia, Total in Water	APHA 4500-NH3 G*	Automated Colorimetry (Phenate)	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Conductivity in Water	APHA 2510 B	Conductivity Meter	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Nitrogen, Total Kjeldahl in Water	APHA 4500-Norg D*	Block Digestion and Flow Injection Analysis	Kelowna
pH in Water	APHA 4500-H+ B	Electrometry	Kelowna
Phosphorus, Total by Colorimetry in Water	APHA 4500-P B.5* / APHA 4500-P F	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	Kelowna
Solids, Total Dissolved in Water	APHA 2540 C*	Gravimetry (Dried at 103-105C)	Kelowna
Solids, Total Suspended in Water	APHA 2540 D*	Gravimetry (Dried at 103-105C)	Kelowna

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
pH units	pH < 7 = acidic, ph > 7 = basic
µS/cm	Microsiemens per centimetre

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Piteau Associates Engineering Ltd. (Kelowna)
PROJECT 3583

WORK ORDER 6061747
REPORTED 2016-06-29

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: MW-1 (6061747-01) [Water] Sampled: 2016-06-21 12:30						
Anions						
Bromide	< 0.10	0.10	mg/L	N/A	2016-06-22	
Chloride	**37.6**	0.10	mg/L	N/A	2016-06-22	
Nitrate (as N)	**6.17**	0.010	mg/L	N/A	2016-06-22	
Nitrite (as N)	< 0.010	0.010	mg/L	N/A	2016-06-22	
Phosphate (as P)	**0.03**	0.01	mg/L	N/A	2016-06-22	
Sulfate	**42.8**	1.0	mg/L	N/A	2016-06-22	
General Parameters						
Alkalinity, Total (as CaCO3)	**225**	2	mg/L	N/A	2016-06-22	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L	N/A	2016-06-22	
Alkalinity, Bicarbonate (as CaCO3)	**225**	2	mg/L	N/A	2016-06-22	
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L	N/A	2016-06-22	
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L	N/A	2016-06-22	
Ammonia, Total (as N)	**0.023**	0.020	mg/L	N/A	2016-06-24	
Conductivity (EC)	**674**	2	µS/cm	N/A	2016-06-22	
Nitrogen, Total Kjeldahl	**0.39**	0.05	mg/L	2016-06-24	2016-06-27	
pH	**7.79**	0.01	pH units	N/A	2016-06-22	HT2
Phosphorus, Total (as P)	**0.161**	0.002	mg/L	2016-06-23	2016-06-24	
Solids, Total Dissolved	**387**	10	mg/L	N/A	2016-06-23	
Solids, Total Suspended	**144**	2	mg/L	N/A	2016-06-22	
Calculated Parameters						
Hardness, Total (as CaCO3)	**287**	5.0	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	**6.17**	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**6.56**	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.366**	0.050	mg/L	N/A	N/A	
Dissolved Metals						
Aluminum, dissolved	< 0.05	0.05	mg/L	N/A	2016-06-24	
Antimony, dissolved	< 0.001	0.001	mg/L	N/A	2016-06-24	
Arsenic, dissolved	< 0.005	0.005	mg/L	N/A	2016-06-24	
Barium, dissolved	**0.12**	0.05	mg/L	N/A	2016-06-24	
Beryllium, dissolved	< 0.001	0.001	mg/L	N/A	2016-06-24	
Bismuth, dissolved	< 0.001	0.001	mg/L	N/A	2016-06-24	
Boron, dissolved	**0.04**	0.04	mg/L	N/A	2016-06-24	
Cadmium, dissolved	< 0.0001	0.0001	mg/L	N/A	2016-06-24	
Calcium, dissolved	**86.4**	2.0	mg/L	N/A	2016-06-24	
Chromium, dissolved	< 0.005	0.005	mg/L	N/A	2016-06-24	
Cobalt, dissolved	< 0.0005	0.0005	mg/L	N/A	2016-06-24	
Copper, dissolved	< 0.002	0.002	mg/L	N/A	2016-06-24	
Iron, dissolved	**0.18**	0.10	mg/L	N/A	2016-06-24	
Lead, dissolved	< 0.001	0.001	mg/L	N/A	2016-06-24	
Lithium, dissolved	**0.009**	0.001	mg/L	N/A	2016-06-24	
Magnesium, dissolved	**17.3**	0.1	mg/L	N/A	2016-06-24	
Manganese, dissolved	**0.016**	0.002	mg/L	N/A	2016-06-24	
Mercury, dissolved	< 0.00002	0.00002	mg/L	2016-06-23	2016-06-28	
Molybdenum, dissolved	**0.020**	0.001	mg/L	N/A	2016-06-24	

REPORTED TO	Piteau Associates Engineering Ltd. (Kelowna)	**WORK ORDER**	6061747
PROJECT	3583	**REPORTED**	2016-06-29

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: MW-1 (6061747-01) [Water] Sampled: 2016-06-21 12:30, Continued						
Dissolved Metals, Continued						
Nickel, dissolved	**0.003**	0.002	mg/L	N/A	2016-06-24	
Phosphorus, dissolved	< 0.2	0.2	mg/L	N/A	2016-06-24	
Potassium, dissolved	**4.8**	0.2	mg/L	N/A	2016-06-24	
Selenium, dissolved	< 0.005	0.005	mg/L	N/A	2016-06-24	
Silicon, dissolved	**10**	5	mg/L	N/A	2016-06-24	
Silver, dissolved	< 0.0005	0.0005	mg/L	N/A	2016-06-24	
Sodium, dissolved	**27.2**	0.2	mg/L	N/A	2016-06-24	
Strontium, dissolved	**0.81**	0.01	mg/L	N/A	2016-06-24	
Sulfur, dissolved	**10**	10	mg/L	N/A	2016-06-24	
Tellurium, dissolved	< 0.002	0.002	mg/L	N/A	2016-06-24	
Thallium, dissolved	< 0.0002	0.0002	mg/L	N/A	2016-06-24	
Thorium, dissolved	< 0.001	0.001	mg/L	N/A	2016-06-24	
Tin, dissolved	< 0.002	0.002	mg/L	N/A	2016-06-24	
Titanium, dissolved	< 0.05	0.05	mg/L	N/A	2016-06-24	
Uranium, dissolved	**0.0171**	0.0002	mg/L	N/A	2016-06-24	
Vanadium, dissolved	< 0.01	0.01	mg/L	N/A	2016-06-24	
Zinc, dissolved	< 0.04	0.04	mg/L	N/A	2016-06-24	
Zirconium, dissolved	< 0.001	0.001	mg/L	N/A	2016-06-24	

Sample / Analysis Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

REPORTED TO	Piteau Associates Engineering Ltd. (Kelowna)	**WORK ORDER**	6061747
PROJECT	3583	**REPORTED**	2016-06-29

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup):** Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS):** A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM):** A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6F1457										
Blank (B6F1457-BLK1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Bromide	< 0.10	0.10	mg/L							
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
Phosphate (as P)	< 0.01	0.01	mg/L							
Sulfate	< 1.0	1.0	mg/L							
Blank (B6F1457-BLK2)				Prepared: 2016-06-23, Analyzed: 2016-06-23						
Bromide	< 0.10	0.10	mg/L							
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
Phosphate (as P)	< 0.01	0.01	mg/L							
Sulfate	< 1.0	1.0	mg/L							
LCS (B6F1457-BS1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Bromide	4.06	0.10	mg/L	4.00		102	85-115			
Chloride	16.3	0.10	mg/L	16.0		102	90-110			
Nitrate (as N)	4.27	0.010	mg/L	4.00		107	93-108			
Nitrite (as N)	2.03	0.010	mg/L	2.00		101	83-110			
Phosphate (as P)	1.00	0.01	mg/L	1.00		100	85-115			
Sulfate	15.8	1.0	mg/L	16.0		99	91-109			
LCS (B6F1457-BS2)				Prepared: 2016-06-23, Analyzed: 2016-06-23						
Bromide	4.17	0.10	mg/L	4.00		104	85-115			
Chloride	16.3	0.10	mg/L	16.0		102	90-110			
Nitrate (as N)	4.12	0.010	mg/L	4.00		103	93-108			
Nitrite (as N)	2.03	0.010	mg/L	2.00		101	83-110			
Phosphate (as P)	1.09	0.01	mg/L	1.00		109	85-115			
Sulfate	15.9	1.0	mg/L	16.0		99	91-109			
Duplicate (B6F1457-DUP1)		**Source: 6061747-01**		Prepared: 2016-06-22, Analyzed: 2016-06-22						
Bromide	< 0.10	0.10	mg/L		< 0.10				10	

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6F1457, Continued										
Duplicate (B6F1457-DUP1), Continued		**Source: 6061747-01**		Prepared: 2016-06-22, Analyzed: 2016-06-22						
Chloride	37.7	0.10	mg/L		37.6			< 1	10	
Nitrate (as N)	6.08	0.010	mg/L		6.17			1	10	
Nitrite (as N)	< 0.010	0.010	mg/L		< 0.010				6	
Phosphate (as P)	0.03	0.01	mg/L		0.03				20	
Sulfate	42.6	1.0	mg/L		42.8			< 1	6	
Matrix Spike (B6F1457-MS1)		**Source: 6061747-01**		Prepared: 2016-06-22, Analyzed: 2016-06-22						
Bromide	4.18	0.10	mg/L	4.00	< 0.10	103	75-125			
Chloride	55.8	0.10	mg/L	16.0	37.6	114	75-125			
Nitrate (as N)	10.2	0.010	mg/L	4.00	6.17	102	75-125			
Nitrite (as N)	2.01	0.010	mg/L	2.00	< 0.010	100	75-125			
Phosphate (as P)	1.12	0.01	mg/L	1.00	0.03	109	75-125			
Sulfate	59.0	1.0	mg/L	16.0	42.8	101	75-125			
Dissolved Metals, Batch B6F1569										
Blank (B6F1569-BLK1)				Prepared: 2016-06-23, Analyzed: 2016-06-28						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Reference (B6F1569-SRM1)				Prepared: 2016-06-23, Analyzed: 2016-06-28						
Mercury, dissolved	0.00374	0.00002	mg/L	0.00456		82	50-150			
Dissolved Metals, Batch B6F1583										
Blank (B6F1583-BLK1)				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Aluminum, dissolved	< 0.05	0.05	mg/L							
Antimony, dissolved	< 0.001	0.001	mg/L							
Arsenic, dissolved	< 0.005	0.005	mg/L							
Barium, dissolved	< 0.05	0.05	mg/L							
Beryllium, dissolved	< 0.001	0.001	mg/L							
Bismuth, dissolved	< 0.001	0.001	mg/L							
Boron, dissolved	< 0.04	0.04	mg/L							
Cadmium, dissolved	< 0.0001	0.0001	mg/L							
Calcium, dissolved	< 2.0	2.0	mg/L							
Chromium, dissolved	< 0.005	0.005	mg/L							
Cobalt, dissolved	< 0.0005	0.0005	mg/L							
Copper, dissolved	< 0.002	0.002	mg/L							
Iron, dissolved	< 0.10	0.10	mg/L							
Lead, dissolved	< 0.001	0.001	mg/L							
Lithium, dissolved	< 0.001	0.001	mg/L							
Magnesium, dissolved	< 0.1	0.1	mg/L							
Manganese, dissolved	< 0.002	0.002	mg/L							
Molybdenum, dissolved	< 0.001	0.001	mg/L							
Nickel, dissolved	< 0.002	0.002	mg/L							
Phosphorus, dissolved	< 0.2	0.2	mg/L							
Potassium, dissolved	< 0.2	0.2	mg/L							
Selenium, dissolved	< 0.005	0.005	mg/L							
Silicon, dissolved	< 5	5	mg/L							
Silver, dissolved	< 0.0005	0.0005	mg/L							
Sodium, dissolved	< 0.2	0.2	mg/L							
Strontium, dissolved	< 0.01	0.01	mg/L							
Sulfur, dissolved	< 10	10	mg/L							
Tellurium, dissolved	< 0.002	0.002	mg/L							
Thallium, dissolved	< 0.0002	0.0002	mg/L							
Thorium, dissolved	< 0.001	0.001	mg/L							
Tin, dissolved	< 0.002	0.002	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B6F1583, Continued										
Blank (B6F1583-BLK1), Continued				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Titanium, dissolved	< 0.05	0.05	mg/L							
Uranium, dissolved	< 0.0002	0.0002	mg/L							
Vanadium, dissolved	< 0.01	0.01	mg/L							
Zinc, dissolved	< 0.04	0.04	mg/L							
Zirconium, dissolved	< 0.001	0.001	mg/L							
Matrix Spike (B6F1583-MS1)		Source: 6061747-01		Prepared: 2016-06-24, Analyzed: 2016-06-24						
Antimony, dissolved	0.395	0.001	mg/L	0.400	< 0.001	99	71-112			
Arsenic, dissolved	0.209	0.005	mg/L	0.200	< 0.005	104	82-112			
Barium, dissolved	1.13	0.05	mg/L	1.00	0.12	102	80-109			
Beryllium, dissolved	0.103	0.001	mg/L	0.100	< 0.001	103	75-111			
Cadmium, dissolved	0.103	0.0001	mg/L	0.100	< 0.0001	103	84-109			
Chromium, dissolved	0.415	0.005	mg/L	0.400	< 0.005	103	87-115			
Cobalt, dissolved	0.405	0.0005	mg/L	0.400	< 0.0005	101	85-118			
Copper, dissolved	0.420	0.002	mg/L	0.400	0.002	105	84-121			
Iron, dissolved	2.03	0.10	mg/L	2.00	0.18	93	71-129			
Lead, dissolved	0.174	0.001	mg/L	0.200	< 0.001	87	81-111			
Manganese, dissolved	0.379	0.002	mg/L	0.400	0.016	91	66-125			
Nickel, dissolved	0.411	0.002	mg/L	0.400	0.003	102	85-115			
Selenium, dissolved	0.111	0.005	mg/L	0.100	< 0.005	109	77-113			
Silver, dissolved	0.102	0.0005	mg/L	0.100	< 0.0005	102	52-131			
Thallium, dissolved	0.107	0.0002	mg/L	0.100	< 0.0002	107	82-111			
Vanadium, dissolved	0.45	0.01	mg/L	0.400	< 0.01	111	85-111			
Zinc, dissolved	0.61	0.04	mg/L	0.600	< 0.04	101	85-115			
Reference (B6F1583-SRM1)				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Aluminum, dissolved	0.20	0.05	mg/L	0.233		87	58-142			
Antimony, dissolved	0.048	0.001	mg/L	0.0430		113	75-125			
Arsenic, dissolved	0.447	0.005	mg/L	0.438		102	81-119			
Barium, dissolved	3.64	0.05	mg/L	3.35		109	83-117			
Beryllium, dissolved	0.219	0.001	mg/L	0.213		103	80-120			
Boron, dissolved	1.75	0.04	mg/L	1.74		100	74-117			
Cadmium, dissolved	0.237	0.0001	mg/L	0.224		106	83-117			
Calcium, dissolved	7.6	2.0	mg/L	7.69		98	76-124			
Chromium, dissolved	0.456	0.005	mg/L	0.437		104	81-119			
Cobalt, dissolved	0.135	0.0005	mg/L	0.128		106	76-124			
Copper, dissolved	0.928	0.002	mg/L	0.844		110	84-116			
Iron, dissolved	1.24	0.10	mg/L	1.29		96	74-126			
Lead, dissolved	0.103	0.001	mg/L	0.112		92	72-128			
Lithium, dissolved	0.112	0.001	mg/L	0.104		108	60-140			
Magnesium, dissolved	6.6	0.1	mg/L	6.92		95	81-119			
Manganese, dissolved	0.322	0.002	mg/L	0.345		93	84-116			
Molybdenum, dissolved	0.448	0.001	mg/L	0.426		105	83-117			
Nickel, dissolved	0.892	0.002	mg/L	0.840		106	74-126			
Phosphorus, dissolved	0.4	0.2	mg/L	0.495		75	68-132			
Potassium, dissolved	3.1	0.2	mg/L	3.19		96	74-126			
Selenium, dissolved	0.035	0.005	mg/L	0.0331		107	70-130			
Sodium, dissolved	17.8	0.2	mg/L	19.1		93	72-128			
Strontium, dissolved	0.98	0.01	mg/L	0.916		107	84-113			
Thallium, dissolved	0.0429	0.0002	mg/L	0.0393		109	57-143			
Uranium, dissolved	0.243	0.0002	mg/L	0.266		91	85-115			
Vanadium, dissolved	0.89	0.01	mg/L	0.869		103	87-113			
Zinc, dissolved	0.91	0.04	mg/L	0.881		103	72-128			
General Parameters, Batch B6F1364										

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6F1364, Continued										
Blank (B6F1364-BLK1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							
Conductivity (EC)	< 2	2	µS/cm							
LCS (B6F1364-BS1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Alkalinity, Total (as CaCO3)	99	2	mg/L	100		99	96-108			
LCS (B6F1364-BS2)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Conductivity (EC)	1390	2	µS/cm	1410		99	95-104			
Reference (B6F1364-SRM1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
pH	6.95	0.01	pH units	7.00		99	98-102			
General Parameters, Batch B6F1366										
Blank (B6F1366-BLK1)				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B6F1366-BLK2)				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
LCS (B6F1366-BS1)				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Ammonia, Total (as N)	1.00	0.020	mg/L	1.00		100	86-111			
LCS (B6F1366-BS2)				Prepared: 2016-06-24, Analyzed: 2016-06-24						
Ammonia, Total (as N)	1.04	0.020	mg/L	1.00		104	86-111			
General Parameters, Batch B6F1456										
Blank (B6F1456-BLK1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Solids, Total Suspended	< 1	2	mg/L							
LCS (B6F1456-BS1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Solids, Total Suspended	49	2	mg/L	50.0		98	85-110			
Reference (B6F1456-SRM1)				Prepared: 2016-06-22, Analyzed: 2016-06-22						
Solids, Total Suspended	430	2	mg/L	459		94	80-120			
General Parameters, Batch B6F1558										
Blank (B6F1558-BLK1)				Prepared: 2016-06-23, Analyzed: 2016-06-24						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
Blank (B6F1558-BLK2)				Prepared: 2016-06-23, Analyzed: 2016-06-24						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
Blank (B6F1558-BLK3)				Prepared: 2016-06-23, Analyzed: 2016-06-24						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
LCS (B6F1558-BS1)				Prepared: 2016-06-23, Analyzed: 2016-06-24						
Phosphorus, Total (as P)	0.092	0.002	mg/L	0.100		92	75-112			

REPORTED TO Piteau Associates Engineering Ltd. (Kelowna) **WORK ORDER** 6061747
PROJECT 3583 **REPORTED** 2016-06-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6F1558, Continued										
LCS (B6F1558-BS2)				Prepared: 2016-06-23, Analyzed: 2016-06-24						
Phosphorus, Total (as P)	0.096	0.002	mg/L	0.100		96	75-112			
LCS (B6F1558-BS3)				Prepared: 2016-06-23, Analyzed: 2016-06-24						
Phosphorus, Total (as P)	0.099	0.002	mg/L	0.100		99	75-112			
General Parameters, Batch B6F1568										
Blank (B6F1568-BLK1)				Prepared: 2016-06-23, Analyzed: 2016-06-23						
Solids, Total Dissolved	< 10	10	mg/L							
Reference (B6F1568-SRM1)				Prepared: 2016-06-23, Analyzed: 2016-06-23						
Solids, Total Dissolved	228	10	mg/L	240		95	85-115			
General Parameters, Batch B6F1642										
Blank (B6F1642-BLK1)				Prepared: 2016-06-24, Analyzed: 2016-06-27						
Nitrogen, Total Kjeldahl	< 0.05	0.05	mg/L							
Blank (B6F1642-BLK2)				Prepared: 2016-06-24, Analyzed: 2016-06-27						
Nitrogen, Total Kjeldahl	< 0.05	0.05	mg/L							
LCS (B6F1642-BS1)				Prepared: 2016-06-24, Analyzed: 2016-06-27						
Nitrogen, Total Kjeldahl	10.8	0.05	mg/L	10.0		108	80-120			
LCS (B6F1642-BS2)				Prepared: 2016-06-24, Analyzed: 2016-06-27						
Nitrogen, Total Kjeldahl	10.4	0.05	mg/L	10.0		104	80-120			
Duplicate (B6F1642-DUP2)			**Source: 6061747-01**	Prepared: 2016-06-24, Analyzed: 2016-06-27						
Nitrogen, Total Kjeldahl	0.44	0.05	mg/L		0.39			13	16	
Matrix Spike (B6F1642-MS2)			**Source: 6061747-01**	Prepared: 2016-06-24, Analyzed: 2016-06-27						
Nitrogen, Total Kjeldahl	1.04	0.05	mg/L	1.00	0.39	65	65-135			

CARO ANALYTICAL SERVICES

APPENDIX 3: REVISION HISTORY

REPORTED TO	Piteau Associates Engineering Ltd. (Kelowna)	**WORK ORDER**	6061747
PROJECT	3583	**REPORTED**	2016-06-29

Sample ID	Changed	Change	Analysis	Analyte(s)
6061747-01	2016-06-29	Sample ID	N/A	N/A

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Requisition Form # .
Client Code # ty
Your C.O.C. #: 08422768

Attention:KIRSTIN GALE

FRESHWATER FISHERIES SOCIETY OF BC
ABBOTSFORD (ty)
34345 VYE ROAD
ABBOTSFORD, BC
CANADA V2S 7P6

Report Date: 2016/06/30
Report #: R2208672
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B643286
Received: 2016/06/02, 11:30

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2016/06/03	2016/06/03	BBY6SOP-00026	SM 22 2320 B m
Temperature at Arrival	1	N/A	2016/06/03		
Chloride by Automated Colourimetry	1	N/A	2016/06/06	BBY6SOP-00011	SM 22 4500-Cl- E m
Conductance - water	1	N/A	2016/06/03	BBY6SOP-00026	SM 22 2510 B m
Hardness Total (calculated as CaCO3)	1	N/A	2016/06/06	BBY WI-00033	Auto Calc
Hardness (calculated as CaCO3)	1	N/A	2016/06/07	BBY WI-00033	Auto Calc
Bromide as Bromine (Br) by ICPMS	1	N/A	2016/06/06	BBY7SOP-00002	EPA 6020B R2 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2016/06/07	BBY7SOP-00002	EPA 6020B R2 m
Elements by ICPMS Low Level (dissolved)	1	N/A	2016/06/06	BBY7SOP-00002	EPA 6020B R2 m
Na, K, Ca, Mg, S by CRC ICPMS (total)	1	N/A	2016/06/06	BBY7SOP-00003,	BCLM2005,EPA6020bR2m
Elements by ICPMS Low Level (total)	1	N/A	2016/06/04	BBY7SOP-00003,	BCLM2005,EPA6020bR2m
Nitrogen (Total)	1	2016/06/06	2016/06/07	BBY6SOP-00016	SM 22 4500-N C m
Ammonia-N (Preserved)	1	N/A	2016/06/03	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate+Nitrite (N) (low level)	1	N/A	2016/06/03	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) (low level)	1	N/A	2016/06/03	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	1	N/A	2016/06/03	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen (Organic) (Cal. TKN, NH4,N/N)	1	N/A	2016/06/07	BBY WI-00033	Auto Calc
Filter and HNO3 Preserve for Metals	1	N/A	2016/06/06	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	1	N/A	2016/06/03	BBY6SOP-00026	SM 22 4500-H+ B m
Orthophosphate by Konelab (low level)	1	N/A	2016/06/03	BBY6SOP-00013	SM 22 4500-P E m
Sulphate by Automated Colourimetry	1	N/A	2016/06/06	BBY6SOP-00017	SM 22 4500-SO42- E m
Sampling Range	1	N/A	2016/06/03		
Total Dissolved Solids (Filt. Residue)	1	2016/06/04	2016/06/06	BBY6SOP-00033	SM 22 2540 C m
TKN (Calc. TN, N/N) total	1	N/A	2016/06/07	BBY WI-00033	Calculation
Phosphorus-P (LL Tot, dissolved) - UF/UP	1	2016/06/04	2016/06/04	BBY6SOP-00013	SM 22 4500-P E m
Total Phosphorus - unpreserved	1	N/A	2016/06/04	BBY6SOP-00013	SM 22 4500-P E m
Total Suspended Solids	1	2016/06/06	2016/06/07	BBY6SOP-00034	SM 22 2540 D

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

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Your Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Requisition Form # .
Client Code # ty
Your C.O.C. #: 08422768

Attention:KIRSTIN GALE
FRESHWATER FISHERIES SOCIETY OF BC
ABBOTSFORD (ty)
34345 VYE ROAD
ABBOTSFORD, BC
CANADA V2S 7P6

Report Date: 2016/06/30
Report #: R2208672
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B643286
Received: 2016/06/02, 11:30

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Morgan Melnychuk, Burnaby Project Manager
Email: MMelnychuk@maxxam.ca
Phone# (604)638-8034 Ext:8034

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Maxxam Job #: B643286
Report Date: 2016/06/30

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		OT0696		
Sampling Date		2016/06/01 11:25		
COC Number		08422768		
	UNITS	STH SPRING (EMS 0500323)	RDL	QC Batch
Field Parameters				
Sample End Date	N/A	20160601	N/A	8286950
Sample End Time	N/A	11:25	N/A	8286950
Sample Start Date	N/A	20160601	N/A	8286950
Sample Start Time	N/A	11:25	N/A	8286950
Temperature at Arrival	C	7		8286944
Calculated Parameters				
Filter and HNO3 Preservation	N/A	LAB	N/A	8287146
Total Hardness (CaCO3)	mg/L	281	0.50	8286176
Nitrate (N)	mg/L	3.83	0.0020	8286242
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	284	0.50	8286070
Alkalinity (Total as CaCO3)	mg/L	218	0.50	8287646
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	8287646
Bicarbonate (HCO3)	mg/L	266	0.50	8287646
Carbonate (CO3)	mg/L	<0.50	0.50	8287646
Hydroxide (OH)	mg/L	<0.50	0.50	8287646
Anions				
Orthophosphate (P)	mg/L	0.0088	0.0010	8288171
Dissolved Sulphate (SO4)	mg/L	42.6	0.50	8289911
Dissolved Chloride (Cl)	mg/L	31	0.50	8289694
Nutrients				
Total Kjeldahl Nitrogen (Calc)	mg/L	<0.10	0.10	8286288
Total Organic Nitrogen (N)	mg/L	<0.10	0.10	8286664
Dissolved Phosphorus (P)	mg/L	0.0097	0.0020	8288630
Total Ammonia (N)	mg/L	0.012	0.0050	8288155
Nitrate plus Nitrite (N)	mg/L	3.83	0.0020	8288055
Nitrite (N)	mg/L	<0.0020	0.0020	8288058
Total Nitrogen (N)	mg/L	3.79 (1)	0.10	8290016

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

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Maxxam Job #: B643286
Report Date: 2016/06/30

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		OT0696		
Sampling Date		2016/06/01 11:25		
COC Number		08422768		
	UNITS	STH SPRING (EMS 0500323)	RDL	QC Batch
Total Phosphorus (P)	mg/L	0.0115	0.0020	8288632
Physical Properties				
Conductivity	uS/cm	634	1.0	8287644
pH	pH	8.15		8287641
Physical Properties				
Total Suspended Solids	mg/L	<4.0	4.0	8289331
Total Dissolved Solids	mg/L	350	10	8288507
RDL = Reportable Detection Limit				

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Maxxam Job #: B643286
Report Date: 2016/06/30

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		OT0696		
Sampling Date		2016/06/01 11:25		
COC Number		08422768		
	UNITS	STH SPRING (EMS 0500323)	RDL	QC Batch
ANIONS				
Bromide (Br)	mg/L	<0.10 (1)	0.10	8281440
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	1.19	0.50	8287481
Dissolved Antimony (Sb)	ug/L	0.036	0.020	8287481
Dissolved Arsenic (As)	ug/L	0.786	0.020	8287481
Dissolved Barium (Ba)	ug/L	92.5	0.020	8287481
Dissolved Beryllium (Be)	ug/L	<0.010	0.010	8287481
Dissolved Bismuth (Bi)	ug/L	<0.0050	0.0050	8287481
Dissolved Boron (B)	ug/L	37	10	8287481
Dissolved Cadmium (Cd)	ug/L	0.0690	0.0050	8287481
Dissolved Chromium (Cr)	ug/L	0.62	0.10	8287481
Dissolved Cobalt (Co)	ug/L	0.0410	0.0050	8287481
Dissolved Copper (Cu)	ug/L	1.51	0.050	8287481
Dissolved Iron (Fe)	ug/L	<1.0	1.0	8287481
Dissolved Lead (Pb)	ug/L	0.0260	0.0050	8287481
Dissolved Lithium (Li)	ug/L	7.80	0.50	8287481
Dissolved Manganese (Mn)	ug/L	0.228	0.050	8287481
Dissolved Molybdenum (Mo)	ug/L	16.6	0.050	8287481
Dissolved Nickel (Ni)	ug/L	0.392	0.020	8287481
Dissolved Selenium (Se)	ug/L	1.22	0.040	8287481
Dissolved Silver (Ag)	ug/L	<0.0050	0.0050	8287481
Dissolved Strontium (Sr)	ug/L	766	0.050	8287481
Dissolved Thallium (Tl)	ug/L	0.0030	0.0020	8287481
Dissolved Tin (Sn)	ug/L	<0.20	0.20	8287481
Dissolved Uranium (U)	ug/L	21.9	0.0020	8287481
Dissolved Vanadium (V)	ug/L	1.29	0.20	8287481
Dissolved Zinc (Zn)	ug/L	1.88 (2)	0.10	8287481
Dissolved Calcium (Ca)	mg/L	86.4	0.050	8286317
Dissolved Magnesium (Mg)	mg/L	16.6	0.050	8286317

RDL = Reportable Detection Limit
(1) RDL raised due to sample matrix interference.
(2) Dissolved greater than total. Reanalysis yields similar results.

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Maxxam Job #: B643286
Report Date: 2016/06/30

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		OT0696		
Sampling Date		2016/06/01 11:25		
COC Number		08422768		
	UNITS	STH SPRING (EMS 0500323)	RDL	QC Batch
Dissolved Potassium (K)	mg/L	4.25	0.050	8286317
Dissolved Sodium (Na)	mg/L	24.3	0.050	8286317
Total Metals by ICPMS				
Total Aluminum (Al)	ug/L	13.1	0.50	8287232
Total Antimony (Sb)	ug/L	0.041	0.020	8287232
Total Arsenic (As)	ug/L	0.823	0.020	8287232
Total Barium (Ba)	ug/L	85.9	0.020	8287232
Total Beryllium (Be)	ug/L	<0.010	0.010	8287232
Total Bismuth (Bi)	ug/L	0.0120	0.0050	8287232
Total Boron (B)	ug/L	41	10	8287232
Total Cadmium (Cd)	ug/L	0.0570	0.0050	8287232
Total Chromium (Cr)	ug/L	0.62	0.10	8287232
Total Cobalt (Co)	ug/L	0.0550	0.0050	8287232
Total Copper (Cu)	ug/L	1.34	0.050	8287232
Total Iron (Fe)	ug/L	21.1	1.0	8287232
Total Lead (Pb)	ug/L	0.0470	0.0050	8287232
Total Lithium (Li)	ug/L	7.13	0.50	8287232
Total Manganese (Mn)	ug/L	0.654	0.050	8287232
Total Molybdenum (Mo)	ug/L	16.5	0.050	8287232
Total Nickel (Ni)	ug/L	0.388	0.020	8287232
Total Selenium (Se)	ug/L	1.29	0.040	8287232
Total Silver (Ag)	ug/L	<0.0050	0.0050	8287232
Total Strontium (Sr)	ug/L	709	0.050	8287232
Total Thallium (Tl)	ug/L	0.0020	0.0020	8287232
Total Tin (Sn)	ug/L	<0.20	0.20	8287232
Total Uranium (U)	ug/L	21.1	0.0020	8287232
Total Vanadium (V)	ug/L	1.38	0.20	8287232
Total Zinc (Zn)	ug/L	1.26	0.10	8287232
Total Calcium (Ca)	mg/L	87.4	0.050	8286663
Total Magnesium (Mg)	mg/L	15.1	0.050	8286663
Total Potassium (K)	mg/L	3.86	0.050	8286663
RDL = Reportable Detection Limit				

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Maxxam Job #: B643286
Report Date: 2016/06/30

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		OT0696		
Sampling Date		2016/06/01 11:25		
COC Number		08422768		
	UNITS	STH SPRING (EMS 0500323)	RDL	QC Batch
Total Sodium (Na)	mg/L	23.1	0.050	8286663
RDL = Reportable Detection Limit				

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FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

GENERAL COMMENTS

Revised report V2 (2016/06/29): Per client request, report includes Total and Dissolved Sodium and Potassium (MM4).

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B643286
Report Date: 2016/06/30

QUALITY ASSURANCE REPORT

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8281440	Bromide (Br)	2016/06/06	96	78 - 120	97	80 - 120	<0.010	mg/L	NC	20
8287232	Total Aluminum (Al)	2016/06/03	112	80 - 120	110	80 - 120	<0.50	ug/L	NC	20
8287232	Total Antimony (Sb)	2016/06/03	107	80 - 120	104	80 - 120	<0.020	ug/L	NC	20
8287232	Total Arsenic (As)	2016/06/03	109	80 - 120	110	80 - 120	<0.020	ug/L	NC	20
8287232	Total Barium (Ba)	2016/06/03	107	80 - 120	103	80 - 120	<0.020	ug/L	NC	20
8287232	Total Beryllium (Be)	2016/06/03	112	80 - 120	111	80 - 120	<0.010	ug/L	NC	20
8287232	Total Bismuth (Bi)	2016/06/03	104	80 - 120	106	80 - 120	<0.0050	ug/L	NC	20
8287232	Total Boron (B)	2016/06/03	108	80 - 120	109	80 - 120	<10	ug/L	NC	20
8287232	Total Cadmium (Cd)	2016/06/03	107	80 - 120	106	80 - 120	<0.0050	ug/L	NC	20
8287232	Total Chromium (Cr)	2016/06/03	107	80 - 120	108	80 - 120	<0.10	ug/L	NC	20
8287232	Total Cobalt (Co)	2016/06/03	108	80 - 120	108	80 - 120	<0.0050	ug/L	NC	20
8287232	Total Copper (Cu)	2016/06/03	108	80 - 120	109	80 - 120	<0.050	ug/L	NC	20
8287232	Total Iron (Fe)	2016/06/03	115	80 - 120	114	80 - 120	<1.0	ug/L	NC	20
8287232	Total Lead (Pb)	2016/06/03	104	80 - 120	106	80 - 120	<0.0050	ug/L	NC	20
8287232	Total Lithium (Li)	2016/06/03	97	80 - 120	97	80 - 120	<0.50	ug/L	NC	20
8287232	Total Manganese (Mn)	2016/06/03	103	80 - 120	105	80 - 120	<0.050	ug/L	NC	20
8287232	Total Molybdenum (Mo)	2016/06/03	103	80 - 120	104	80 - 120	<0.050	ug/L	NC	20
8287232	Total Nickel (Ni)	2016/06/03	107	80 - 120	108	80 - 120	<0.020	ug/L	NC	20
8287232	Total Selenium (Se)	2016/06/03	110	80 - 120	104	80 - 120	<0.040	ug/L	NC	20
8287232	Total Silver (Ag)	2016/06/03	107	80 - 120	97	80 - 120	<0.0050	ug/L	NC	20
8287232	Total Strontium (Sr)	2016/06/03	99	80 - 120	100	80 - 120	<0.050	ug/L	NC	20
8287232	Total Thallium (Tl)	2016/06/03	106	80 - 120	109	80 - 120	<0.0020	ug/L	NC	20
8287232	Total Tin (Sn)	2016/06/03	107	80 - 120	108	80 - 120	<0.20	ug/L	NC	20
8287232	Total Uranium (U)	2016/06/03	102	80 - 120	103	80 - 120	<0.0020	ug/L	NC	20
8287232	Total Vanadium (V)	2016/06/03	107	80 - 120	107	80 - 120	<0.20	ug/L	NC	20
8287232	Total Zinc (Zn)	2016/06/03	115	80 - 120	113	80 - 120	<0.10	ug/L	NC	20
8287481	Dissolved Aluminum (Al)	2016/06/06	109	80 - 120	111	80 - 120	<0.50	ug/L	1.8	20
8287481	Dissolved Antimony (Sb)	2016/06/06	102	80 - 120	103	80 - 120	<0.020	ug/L	NC	20
8287481	Dissolved Arsenic (As)	2016/06/06	104	80 - 120	105	80 - 120	<0.020	ug/L	1.9	20
8287481	Dissolved Barium (Ba)	2016/06/06	NC	80 - 120	103	80 - 120	<0.020	ug/L	1.1	20
8287481	Dissolved Beryllium (Be)	2016/06/06	99	80 - 120	101	80 - 120	<0.010	ug/L	NC	20

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Maxxam Job #: B643286
Report Date: 2016/06/30

QUALITY ASSURANCE REPORT(CONT'D)

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8287481	Dissolved Bismuth (Bi)	2016/06/06	102	80 - 120	105	80 - 120	<0.0050	ug/L	NC	20
8287481	Dissolved Boron (B)	2016/06/06	NC	80 - 120	97	80 - 120	<10	ug/L	2.5	20
8287481	Dissolved Cadmium (Cd)	2016/06/06	101	80 - 120	101	80 - 120	<0.0050	ug/L	NC	20
8287481	Dissolved Chromium (Cr)	2016/06/06	101	80 - 120	102	80 - 120	<0.10	ug/L	NC	20
8287481	Dissolved Cobalt (Co)	2016/06/06	100	80 - 120	103	80 - 120	<0.0050	ug/L	NC	20
8287481	Dissolved Copper (Cu)	2016/06/06	100	80 - 120	104	80 - 120	<0.050	ug/L	4.0	20
8287481	Dissolved Iron (Fe)	2016/06/06	NC	80 - 120	110	80 - 120	<1.0	ug/L	0.74	20
8287481	Dissolved Lead (Pb)	2016/06/06	101	80 - 120	102	80 - 120	<0.0050	ug/L	3.8	20
8287481	Dissolved Lithium (Li)	2016/06/06	NC	80 - 120	102	80 - 120	<0.50	ug/L	5.9	20
8287481	Dissolved Manganese (Mn)	2016/06/06	NC	80 - 120	103	80 - 120	<0.050	ug/L	0.75	20
8287481	Dissolved Molybdenum (Mo)	2016/06/06	NC	80 - 120	100	80 - 120	<0.050	ug/L	1.7	20
8287481	Dissolved Nickel (Ni)	2016/06/06	100	80 - 120	104	80 - 120	<0.020	ug/L	0.99	20
8287481	Dissolved Selenium (Se)	2016/06/06	97	80 - 120	100	80 - 120	<0.040	ug/L	NC	20
8287481	Dissolved Silver (Ag)	2016/06/06	119	80 - 120	97	80 - 120	<0.0050	ug/L	NC	20
8287481	Dissolved Strontium (Sr)	2016/06/06	NC	80 - 120	98	80 - 120	<0.050	ug/L	3.6	20
8287481	Dissolved Thallium (Tl)	2016/06/06	105	80 - 120	109	80 - 120	<0.0020	ug/L	NC	20
8287481	Dissolved Tin (Sn)	2016/06/06	104	80 - 120	106	80 - 120	<0.20	ug/L	NC	20
8287481	Dissolved Uranium (U)	2016/06/06	99	80 - 120	98	80 - 120	<0.0020	ug/L	0.83	20
8287481	Dissolved Vanadium (V)	2016/06/06	NC	80 - 120	101	80 - 120	<0.20	ug/L	1.1	20
8287481	Dissolved Zinc (Zn)	2016/06/06	NC	80 - 120	111	80 - 120	<0.10	ug/L	3.1	20
8287641	pH	2016/06/03			102	97 - 103			0.13	N/A
8287644	Conductivity	2016/06/03			100	80 - 120	<1.0	uS/cm	0	20
8287646	Alkalinity (PP as CaCO3)	2016/06/03					<0.50	mg/L	NC	20
8287646	Alkalinity (Total as CaCO3)	2016/06/03	NC	80 - 120	95	80 - 120	<0.50	mg/L	2.0	20
8287646	Bicarbonate (HCO3)	2016/06/03					<0.50	mg/L	2.0	20
8287646	Carbonate (CO3)	2016/06/03					<0.50	mg/L	NC	20
8287646	Hydroxide (OH)	2016/06/03					<0.50	mg/L	NC	20
8288055	Nitrate plus Nitrite (N)	2016/06/03	107	80 - 120	106	80 - 120	<0.0020	mg/L	4.5	25
8288058	Nitrite (N)	2016/06/03	101	80 - 120	99	80 - 120	<0.0020	mg/L	NC	25
8288155	Total Ammonia (N)	2016/06/03	95	80 - 120	99	80 - 120	<0.0050	mg/L	NC	20
8288171	Orthophosphate (P)	2016/06/03	90	80 - 120	90	80 - 120	<0.0010	mg/L	NC	20

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B643286
Report Date: 2016/06/30

QUALITY ASSURANCE REPORT(CONT'D)

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8288507	Total Dissolved Solids	2016/06/06	103	80 - 120	100	80 - 120	<10	mg/L	4.9	20
8288630	Dissolved Phosphorus (P)	2016/06/04	91	80 - 120	108	80 - 120	0.0022, RDL=0.0020	mg/L	NC	20
8288632	Total Phosphorus (P)	2016/06/04	87	80 - 120	108	80 - 120	0.0022, RDL=0.0020	mg/L	NC	20
8289331	Total Suspended Solids	2016/06/07	100	80 - 120	95	80 - 120	<4.0	mg/L	NC	20
8289694	Dissolved Chloride (Cl)	2016/06/06	104	80 - 120	98	80 - 120	<0.50	mg/L	4.4	20
8289911	Dissolved Sulphate (SO4)	2016/06/06	NC	80 - 120	96	80 - 120	0.58, RDL=0.50	mg/L	1.5	20
8290016	Total Nitrogen (N)	2016/06/07	NC	80 - 120	96	80 - 120	<0.020	mg/L	0.63	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

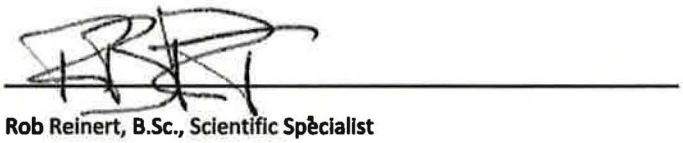
Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B643286
Report Date: 2016/06/30

FRESHWATER FISHERIES SOCIETY OF BC
Client Project #: STH WELL MONITORING
Site Location: SUMMERLAND TROUT, HATCHERY SPRING
Sampler Initials: LC

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Rob Reinert, B.Sc., Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam
A Bureau Veritas Group Company

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5. Toll Free (800) 665-8566

CHAIN OF CUSTODY RECORD

COC 08422768

BBY FCD-00077/05

Page __ 1 of 1

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: Freshwater Fisheries	Company Name:	Quotation #: B50557	X Regular TAT 5 days (Most analyses)
Contact Name: Kirstin Gale	Contact Name:	P.O. #/ AFE#:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 34345 Vye Road	Address:	Project #: STH WELL MONITORING	Rush TAT (Surcharges will be applied)
Abbotsford, BC PC: V2S 7P6	PC:	Site Location: Summerland Trout Hatchery Spring	Same Day / 2 Days / 1 Day / 3 Days
Phone: (604) 855-4720	Phone:	Site #:	Date Required:
Email: kirstin.gale@gofishbc.com	Email:	Sampled By: Laine Cosens	Rush Confirmation #:

Regulatory Criteria	Special Instructions
BC CSR Soil / BC CSR Water / CCME (Specify) / Other (Specify) / Drinking Water / BC Water Quality	Return Cooler / Ship Sample Bottles (Please Specify)

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

	Sample Identification	Lab Identification	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	Alkalinity; Conductivity; pH	Ammonia	Bromide, Chloride, Sulphate	Ammonia	Low Level Total Metals	Low Level Dissolved Metals	Nitrate + Nitrite - Low Level	Nitrite - Low Level	Nitrate - Low Level	Total Nitrogen, TKN, Organic Nitrogen	Orthophosphorus - Low Level	Dissolved Phosphorus - Low Level	Total Phosphorus - Low Level	TDS	TSS - Regular Level	# OF CONTAINERS SUBMITTED	HOLD - DO NOT ANALYZE
1	STH SPRING (EMS 0500323)		2016/06/01	11:25	FW	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	8	
2	SKAHA SPRING (EMS E265402)				FW	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

LABORATORY USE ONLY

CUSTODY SEAL Y / N		COOLER TEMPERATURES
Present	Intact	
NA		7.6 7.1

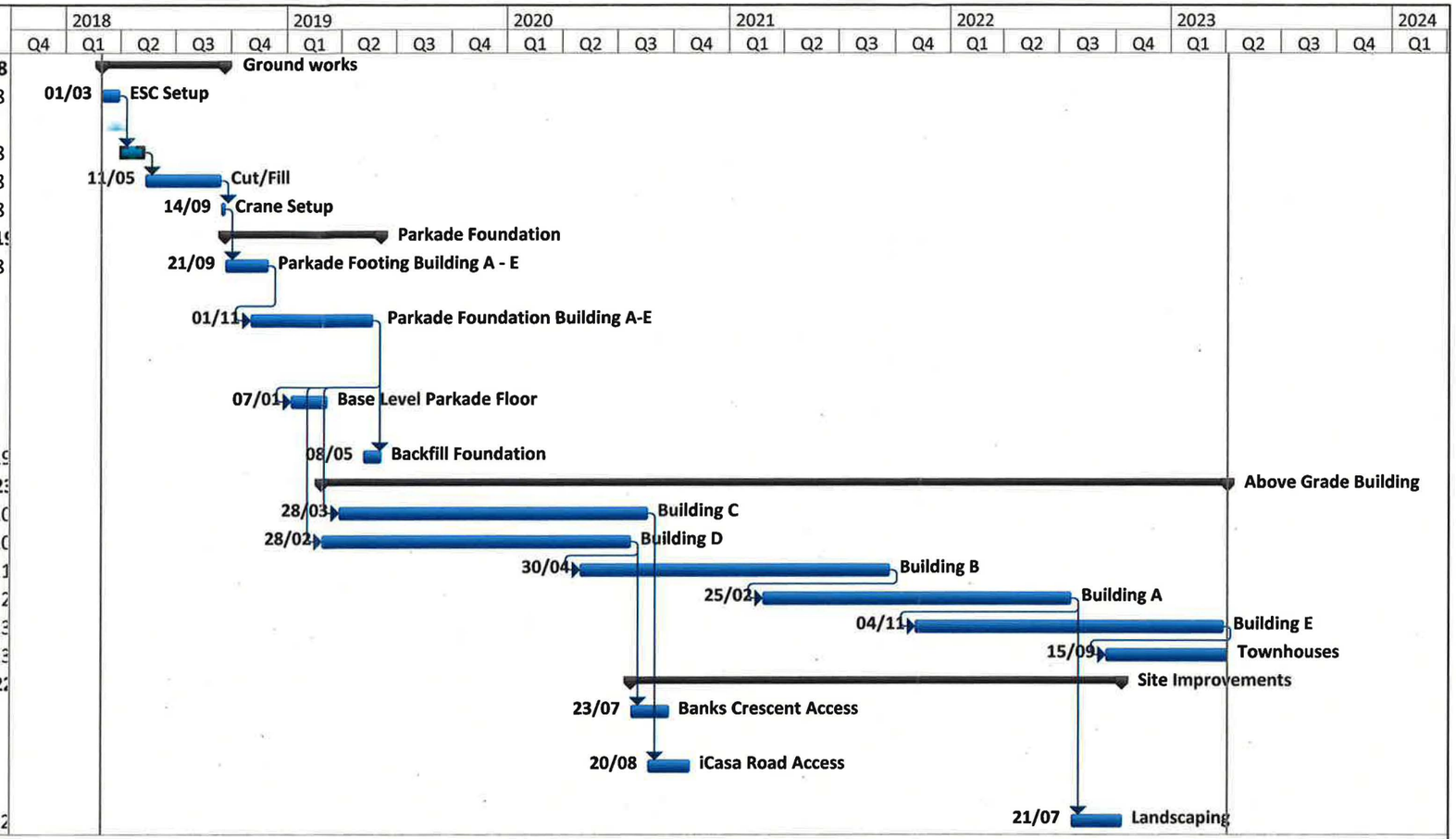
COOLING MEDIA PRESENT Y / N

COMMENTS

B643286_COC

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
Laine Cosens	2016/06/01	11:31	Laurel Berthier	2016/06/02	11:30	~~B647177~~ B643286

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Ground works**	**146 days**	**Thu 01/03/18**	**Thu 20/09/18**
2		ESC Setup	21 days	Thu 01/03/18	Thu 29/03/18
3		Site Setup	30 days		
4		Grubbing/Site Prep	30 days	Fri 30/03/18	Thu 10/05/18
5		Cut/Fill	90 days	Fri 11/05/18	Thu 13/09/18
6		Crane Setup	5 days	Fri 14/09/18	Thu 20/09/18
7		**Parkade Foundation**	**184 days**	**Fri 21/09/18**	**Wed 05/06/19**
8		Parkade Footing Building A - E	50 days	Fri 21/09/18	Thu 29/11/18
9		Parkade Foundation Building A-E	145 days	Thu 01/11/18	Wed 22/05/19
10		Base Level Parkade Floor	45 days	Mon 07/01/19	Fri 08/03/19
11		Backfill Foundation	21 days	Wed 08/05/19	Wed 05/06/19
12		**Above Grade Building**	**1070 days**	**Thu 28/02/19**	**Wed 05/04/23**
13		Building C	365 days	Thu 28/03/19	Wed 19/08/20
14		Building D	365 days	Thu 28/02/19	Wed 22/07/20
15		Building B	365 days	Thu 30/04/20	Wed 22/09/21
16		Building A	365 days	Thu 25/02/21	Wed 20/07/22
17		Building E	365 days	Thu 04/11/21	Wed 29/03/23
18		Townhouses	145 days	Thu 15/09/22	Wed 05/04/23
19		**Site Improvements**	**580 days**	**Thu 23/07/20**	**Wed 12/10/22**
20		Banks Crescent Access	45 days	Thu 23/07/20	Wed 23/09/20
21		iCasa Road Access	50 days	Thu 20/08/20	Wed 28/10/20
22		Landscaping	60 days	Thu 21/07/22	Wed 12/10/22



Project: iCasa Executive Schedule
Date: Fri 29/09/17

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only
Summary	Inactive Task	Duration-only	Finish-only

LARK GROUP
DEVELOP BUILD MANAGE

August 14, 2017

iCasa Resort Living, Summerland BC
at Shaughnessy Green (the "Project")

ATT: **Summerland Mayor and Council**
RE: **Vibration-induced turbidity not a risk to Aquifer**

Dear Mayor and Council,

Further to our letter of July 27th issued to development services describing our enhanced aquifer protection plan during construction, we would like to present two consulting engineers' letters that support the position that vibration-induced turbidity will not pose a risk to the underlying aquifer.

Please find attached from Rock Glen Consulting Ltd. of Okanagan Falls a letter relating to the depth at which vibrations from site are expected to dissipate. In addition, please find attached from Piteau Associates Engineering Ltd. of Kelowna a letter with reference to the Rock Glen Consulting letter that states the depth of the aquifer is substantially lower than the lowest level vibrations are expected to occur due to the attenuation quality of the earth.

Both letters, in conjunction with our enhanced protection plan (attached), serve to support the position that vibration-induced turbidity will not pose a risk to the aquifer. Should the turbidity level of the water leaving the construction site ever exceed the baseline and pre-construction levels, work will be stopped immediately. As required by municipal engineering and construction standards, our water quality monitoring plan and sedimentation and erosion control plan will continue to be in place before, during and after construction to support continued monitoring and data collection from the aquifer.

Sincerely,

Lark Enterprises Ltd.
Malek Tawashy,
Development Project Manager

Attachments (3):
Rock Glen Consulting Ltd. re: Vibratory Attenuation dated August 3rd
Piteau Associates Engineering Ltd. re: Aquifer Depth and monitoring plan dated August 14th
Lark Enterprises Ltd letter to Development Services re: Enhanced Aquifer Protection Plan

Suite 1500, 13737 96 Avenue, Surrey, B.C. Canada V3V 0C6 TEL: 604-576-2935 FAX: 604-576-2936

ROCK GLEN CONSULTING LTD.
P.O. Box 36, Okanagan Falls, BC V0H 1R0
Tel: (250) 497-8290, Fax: (250) 497-8291
rockglen@shaw.ca

August 3, 2017

Lark Group
Suite 1500, 13737 96th Avenue
Surrey, BC
V3V 0C6

Our File: RGC-1839

Attention: Myron Dirks

Subject: Geotechnical Engineering Review of Potential Groundwater Impacts: Proposed ICASA Resort Living Development 13610 Banks Crescent, Summerland, BC

Dear Mr. Dirks:

In response to your request, we are presenting our professional opinion on the potential impacts to the Shaughnessy Spring of proposed construction at 13610 Banks Crescent.

Rock Glen Consulting is retained as the geotechnical engineers for this project. As such, we have been involved in site investigations and review of construction plans for the project. We are well informed regarding the potential impacts of construction on the underlying aquifer.

Test pit excavations and test drilling did not encounter groundwater within planned construction depths. Soils associated with planned excavations and building construction include typical Okanagan glaciolacustrine silts as well as fluvial sands and gravels.

Our experience indicates that potential issues of concern are: slope stability, construction vibrations, and stormwater management.

Slope stability issues will be managed with conventional geotechnical construction methodologies. Construction excavation stability will be undertaken by experienced contractors under the direction of qualified geotechnical engineers.

Temporary excavation slopes will be designed and monitored to protect workers on the site, and also to ensure the long-term stability of those slopes once the construction is completed and all the buildings are backfilled. Proper drainage around those buildings for the foundations will ensure ongoing stability as well.

Slope stability outside of building areas will be monitored as construction proceeds and setbacks for construction of roadways, buildings, and other structures on the sites will ensure that the

construction activities do not contribute to changes in the stability of those slopes. In particular, sufficient setbacks and runoff erosion protection measures will be implemented to maintain a low risk of any slope instability issues in the area above the Shaughnessy Spring.

Excess water into the ground on a project such as this is normally associated with stormwater runoff from roof areas, parking areas, and other hard surfaces on the site. Stormwater runoff will be managed by following the Construction Erosion and Sedimentation Control Plan prepared by CTQ. Stormwater runoff will be collected for discharge offsite to eliminate the potential for onsite disposal of stormwater runoff having an impact on either buildings or the underlying aquifer.

Vibrations during construction include vibrations from excavation, backfilling and foundation preparation activities. Vibrations from excavation work are typically minimal – some of the soil materials and the gravels will create vibrations of a minor nature as they are excavated and these will attenuate at shallow depths in the surrounding soil.

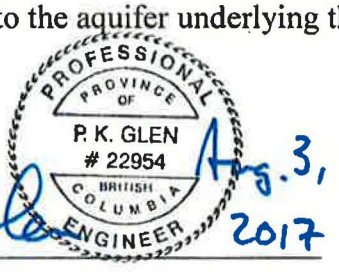
Requirements for structural fill either as foundations under buildings, structural backfill behind retaining walls or building foundations as well as sub-base and base course materials for roadways will be vibratory-packed and these activities will also generate vibrations. The attenuation of these vibrations from even the largest vibratory compactors is expected to attenuate within 5-10 m below where the compaction effort is being applied. On this site, that is estimated to be a maximum of 12 to 15 m below the current ground surface.

RGC is satisfied that the vibrations generated by the excavation and compaction work required to construct the ICASA Resort Living Development will not impact the underlying aquifer, and that the CTQ surface water management plan provides assurance that stormwater runoff from the ICASA site will also not impact the underlying aquifer.

Further, both short-term and long-term slope stability will be managed by adequate setbacks from slopes, including those above the Shaughnessy Spring area, and through construction monitoring by qualified profession engineers.

RGC is confident that construction and operation of the ICASA Resort Living Development represents a very low risk to the aquifer underlying the site and to the water discharged from the Shaughnessy Spring.

Sincerely,



Aug. 3, 2017

Paul Glen, P. Eng.
Rock Glen Consulting Ltd.

PITEAU ASSOCIATES
GEOTECHNICAL AND
WATER MANAGEMENT CONSULTANTS

SUITE 304 - 1912 ENTERPRISE WAY
KELOWNA, B.C.
CANADA - V1Y 8S9
TEL: +1.778.484.1777 / FAX: +1.604.985.7286

www.piteau.com

Our File: 3583-M003

August 14, 2017

Lark Enterprises Ltd.
Suite 1500
13737 – 96th Avenue
Surrey, BC V3V 0C6

Attention: Mr. Myron Dirks, Project Manager

Dear Sirs:

Re: Hydrogeological Update
Proposed ICASA Development at 13610 Banks Crescent, Summerland, BC

Further to your request, we provide the following comments regarding specific issues relating to the proposed ICASSA seniors housing project in Summerland. This letter is further to our original technical memo issued in July 2016 (3583-M001), and a hydrogeological update in January 2017 (3583-M002).

With respect to the August 3, 2017 RockGlen report, this report provides a geotechnical engineering review of potential groundwater impacts at the proposed development. We concur that the potential for vibration induced turbidity to migrate within the aquifer and impact the turbidity in Shaughnessy Springs is negligible. This conclusion is supported by the estimated maximum depth of 10 m to 12 m for the dissipation of vibration generated at ground surface, whereas the most shallow depth to groundwater at the east end of the site is in the order of 20 m. In this regard, we refer to the same technical reference as RockGlen, which is a 2000 paper by Kim & Lee entitled, "Propagation and Attenuation Characteristics of Various Ground Vibrations", derived from the journal Soil Dynamics and Earthquake Engineering.

Other construction activities are not expected to impact the aquifer in any way, however, our understanding is that the groundwater monitoring plan proposed by Piteau will be used during construction to alert the construction team if there are groundwater issues and allow for cessation of work should turbidity levels exceed a high-risk threshold. The monitoring plan provides for baseline (pre-construction) and ongoing water level and water quality monitoring in two dedicated monitoring wells on site during the construction phase of the project. The groundwater monitoring will proceed in conjunction with the erosion and sediment control plan (ESP), which will manage surface runoff quantity and quality during construction.

I trust that these comments are useful for your dialogue with the District of Summerland and the Freshwater Fisheries Society.

Yours truly,

PITEAU ASSOCIATES ENGINEERING LTD.

Remi J. Allard, M.Eng., P.Eng.
Principal Hydrogeologist

RJA/skn

REFERENCES

Kim & Lee. 2000. Propagation and Attenuation Characteristics of Various Ground Vibrations. Journal Soil Dynamics and Earthquake Engineering. V19 (2000).

RockGlen Consulting Ltd. August 2017. Geotechnical Engineering Review of Potential Groundwater Impacts, Proposed ICASSA Resort Living Development, 13610 Banks Crescent, Summerland, BC.

D. 2002. Identifying and Quantifying Urban Recharge: A review. Hydrogeology Journal Volume 10, Issue 1, pp 143-152.

Piteau Associates Engineering. July 2016. Hydrogeological Assessment 13610 Banks Cresecent, Summerland, BC. Technical Memo 3583-M001.

Piteau Associates Engineering. January 2017. Hydrogeological Update (January 4, 2017 Meeting Summary) Technical Memo 3583-M002.

LARK GROUP
DEVELOP BUILD MANAGE

July 27, 2017

iCasa Resort Living, Summerland BC
at Shaughnessy Green (the "Project")

ATT: **Dean Strachan, Director of Development Services, Summerland BC**
RE: **Alternative to Contingency Water Supply**

Dear Mr. Strachan,

Subsequent to hearing from the Freshwater Fisheries Society of BC (FFSBC) at the July 24th, 2017 Council Meeting we would like to present an alternative option for addressing the concerns of the FFSBC. We understand the FFSBC is concerned about construction induced turbidity of the local aquifer that is used by the Hatchery and portions of which may run below the Project site.

As background information, the previously proposed contingency water supply option would have been provided to the District who in turn would have supplied water to the FFSBC for the Hatchery's use. The revised plan presented below provides enhanced protective measures of the aquifer during construction and does not include the provision of a water supply to the District.

The basis of the enhanced protection plan we are working includes the following:

1. Install permanent water monitoring wells on site
2. Begin baseline water quality testing as soon as practicably possible
3. Prior to commencing construction publish the pre-construction turbidity levels and the publically available high-risk turbidity levels that impact fish production
4. During construction provide ongoing water quality monitoring for turbidity with stop-work notifications being issued should the turbidity levels exceed the published high-risk threshold
5. Once work is stopped, and turbidity levels have reduced to acceptable levels, proceed with an approved alternative work method confirmed to reduce vibration-induced turbidity
6. Continue with alternative method until works in the affected area are complete
7. Leave the monitoring wells in place for future hydrology research and data collection

In addition to the above alternative protection measures, all sedimentation and erosion control measures as previously outlined in our erosion and sedimentation control plan will be in place.

Sincerely,

Lark Enterprises Ltd.
Malek Tawashy,
Development Project Manager

Suite 1500, 13737 96 Avenue, Surrey, B.C. Canada V3V 0C6 TEL: 604-576-2935 FAX: 604-576-2936